



COLONEL J. D. CAMPBELL, D.S.O.,
DIRECTOR, SURVEY OF INDIA, 1932-39.

SURVEY OF INDIA

GENERAL REPORT

1939



From 1st October 1938
To 30th September 1939

PUBLISHED BY ORDER OF
THE SURVEYOR GENERAL OF INDIA.

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Survey of India,
CALCUTTA,
1939.

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NOTICES

- I. Work done by the
Survey of India.
- II. How to obtain maps
and other publications.
- III. List of Agents for the
sale of maps.

I. WORK DONE BY THE SURVEY OF INDIA

APPLICATION FOR SURVEYS OF ANY KIND, whether for private or Government purposes, should be made to the following officers :

The Director,	Frontier Circle.	*Survey of India,	Simla.	(Tel. "Surfrontier").
"	"	Geodetic Branch,*	"	Dehra Dūn. (Tel. "Surtrig").
"	"	Eastern Circle,*	"	Shillong. (Tel. "Sureast").
"	O.C.	No. 6 (South India)	"	Bangalore. (Tel. "Surfield Six").
"	"	Party,*	"	
"	"	Burma Survey	"	Maymyo. (Tel. "Surburma").
"	"	Party,*	"	

FOREST AND CANTONMENT SURVEYS, LEVELLING, TRIANGULATION AND TIDE-TABLES. Advice in regard to these, and on scientific questions, is obtainable from the *Director, Geodetic Branch, Survey of India, Dehra Dūn*, who undertakes levelling and similar work for municipalities and engineering projects, on payment. (*Telegrams "Surtrig"*).

MAPS AND ILLUSTRATIONS can be printed by the *Director, Map Publication, Survey of India, 13 Wood Street, Calcutta*, for Government Departments and the public, and special maps can also sometimes be prepared, on payment. (*Telegrams "Surpub"*).

THE MATHEMATICAL INSTRUMENT OFFICE, Survey of India, 15 Wood Street, Calcutta, is a well equipped Government Factory which supplies, manufactures, and repairs all kinds of Surveying, Drawing, Optical, Meteorological, and Medical instruments. It also manufactures special instruments for experimental purposes and receives back surplus instruments on valuation, from all Government Departments, whether Central or Provincial.

The Price List, Rules and Regulations and Forms for Indents, Repairs and Deposits are supplied gratis on application. (*Telegrams "Surinst"*).

GENERAL ENQUIRIES should be addressed to the Assistant Surveyor General, 13 Wood Street, Calcutta (*Telegrams "Surveys"*), as the Surveyor General of India is on tour during most of the year.

* Provinces and States in each Survey Circle.

- | | | |
|--|---|--|
| <p>1. FRONTIER Circle
 Kashmir and Jammu
 Gilgit Agency
 N. W. F. Province
 Baluchistān
 Punjab
 Panjab States
 Sind
 Bikaner State (Rāj-putāna).</p> | <p>2. GEODETIC Branch
 United Provinces
 Central India
 Gwalior
 Ajmer-Merwāra
 Delhi
 Rājputāna (excluding Bikaner).
 Baroda
 Bombay (Northern Division).
 States of Western India.
 Gujarāt States
 Andaman and Nicobar Islands.</p> | <p>3. EASTERN Circle
 Central Provinces and Berār
 Bengal
 Bihar
 Assam and Sikkim
 Bhutān
 Eastern States
 Orissa.</p> |
| <p>5. BURMA SURVEY Party.
 Burma.</p> | <p>4. No. 6 (SOUTH INDIA) Party.
 Madras
 Madras States
 Hyderabad
 Mysore and Coorg
 Bombay (Southern Division).
 Deccan States.</p> | |

II. HOW TO OBTAIN MAPS AND OTHER PUBLICATIONS

SURVEY OF INDIA MAPS are obtainable from the Map Office, 13 Wood Street, Calcutta (*Tel. "Surmaps"*). Also from the Agents listed in Notice III and from the Directors of Survey Circles. A **MAP CATALOGUE**, which itself forms a useful atlas of India and surrounding countries, can be obtained for *Re. 1/- (post free)*.

Burma topographical and cantonment maps are obtainable from the Curator, Government Book Depot, Burma, Rangoon (*Tel. "Printing"*).

FOREST AND CANTONMENT MAPS are obtainable from the Map Office, Survey of India, Dehra Dūn (*Tel. "Surtrig"*). Burma Forest Maps are obtainable from the Conservator of Forests, Working Plans Circle, Burma, Maymyo.

GEOLOGICAL MAPS are prepared by and can be obtained from the Director, Geological Survey, Calcutta.

SURVEY PUBLICATIONS OTHER THAN MAPS, as outlined below, are obtainable through the Director, Geodetic Branch, Survey of India, Dehra Dūn, who will supply a full Catalogue *gratis* on application. The Catalogue is also included in the Annual Geodetic Report.

- (a) *Trigonometrical data.* Triangulation pamphlets, each covering one degree square, giving descriptions, positions, and heights of triangulated points and other data, with chart. Levelling pamphlets, each covering $4^{\circ} \times 4^{\circ}$, giving descriptions and heights of Bench-marks, with chart.

Burma trigonometrical data are obtainable from the Officer in charge, Burma Survey Party, Maymyo.

- (b) *Tidal Predictions*, published annually in advance as *Tide-Tables of the Indian Ocean*. These tables contain predictions for 39 Indian and Burmese ports, and for 28 other ports in various parts of the world.
- (c) *Geodetic works of Reference*—The G.T.S. series of twenty-one large quarto volumes describing in detail the geodetic operations of the Great Trigonometrical Survey from 1800. Detailed accounts are given of the Base-line measurements, of the reduction of the Geodetic Triangulation treated in five portions, of the early Pendulum observations, of Telegraphic Longitude and Astronomical Latitude operations, of Tidal observations, and of Levelling of high precision.
- (d) *Historical, and General Reports*, including the "Memoirs on Indian Surveys" by Sir Clements Markham and C.E.D. Black: also Annual Reports, Narrative Reports. Record Volumes, and the annual Geodetic Reports.
- (e) *Miscellaneous.* Papers on Geodesy, Exploration, etc. including a "Sketch of the Geography and Geology of the Himālaya Mountains and Tibet" (in 4 parts) revised in 1938.

III. LIST OF AGENTS FOR THE SALE OF MAPS

OUT OF INDIA.

- | | | |
|-----------------|----|--|
| <i>England.</i> | 1. | Secretary to the High Commissioner for India, (Genl. Deptt.), India House, Aldwych, London, W. C. 2. |
| | 2. | Sifton Praed & Co. Ltd., The Map House, 67 St. James's Street, London, S. W. 1. |
| <i>America.</i> | 3. | C. S. Hammond & Co., 30 Church St., Hudson Terminal, New York, and 75 State St., Boston, Mass. |
| <i>China.</i> | 4. | French Book Stores, Grand Hotel de Pekin, Peiping. |
| <i>Burma.</i> | 5. | The Curator, Government Book Depot, Burma, Rangoon. |

INDIA.

- | | | |
|--------------------|-----|--|
| <i>Abbottābād.</i> | 1. | English Book Store, opposite Empire Talkies. |
| <i>Āgra.</i> | 2. | English Book Depot, Taj Road. |
| | 3. | Indian Army Book Depot, Dayāl Bāgh. |
| <i>Ajmer.</i> | 4. | Rājputāna Book House. |
| <i>Allahābād.</i> | 5. | North India Christian Tract and Book Society. |
| <i>Ambāla.</i> | 6. | Ram Chander & Sons. |
| | 7. | English Book Depot, Ambāla Cantonment. |
| <i>Bangalore.</i> | 8. | Raja Gopal Photo. Zineo. and Printing Works, Fort Bangalore. |
| <i>Bareilly.</i> | 9. | London Book Depot. |
| <i>Baroda.</i> | 10. | B. Parikh & Co., Māndvi Road. |
| <i>Bombay.</i> | 11. | Thacker & Co. |
| | 12. | D. B. Taraporevala Sons & Co. |
| | 13. | Western India Automobile Association, 12 Wodehouse Road. |
| <i>Calcutta.</i> | 14. | W. Newman & Co., 3 Old Court House Street. |
| | 15. | Automobile Association of Bengal, 40 Chowringhee. |
| | 16. | City Map Agency, Govt. Book Depot, 8 Hastings St. |
| | 17. | Oxford Book & Stationery Co., 17 Park St. |
| | 18. | Thacker Spink & Co., 3 Esplanade East. |
| | 19. | Kali Charan & Co., B. 40-41 Municipal Market. |
| | 20. | Royal Book Store, B. 48 Municipal Market. |
| | 21. | Das Gupta & Co., 54/3 College St. |
| <i>Cawnpore.</i> | 22. | Advani Brothers. |
| <i>Darjeeling.</i> | 23. | Oxford Book & Stationery Co. |
| <i>Dehra Dūn.</i> | 24. | Ideal Book Depot, Rājpur Road. |
| <i>Delhi.</i> | 25. | Oxford Book & Stationery Co., Kashmīr Gate. |
| | 26. | Oxford Book & Stationery Co., Connaught Place, New Delhi. |
| | 27. | Ramesh Book Depot and Stationery Mart. |
| | 28. | J. M. Jaina & Brothers, Mori Gate. |
| | 29. | Bhawnani & Sons, Connaught Place, New Delhi. |
| | 30. | Idandas Book Co., Connaught Circus, New Delhi. |
| <i>Dum-Dum.</i> | 31. | Indian Air Survey & Transport Ltd. |
| <i>Ferozepore.</i> | 32. | English Book Depot, Wazir Ali Buildings. |
| <i>Indore.</i> | 33. | The Manager, Dak Bungalow. |
| | 34. | The Proprietor, Central India High Class Athletic Depot. |
| <i>Jhānsi.</i> | 35. | English Book Depot. |
| <i>Jubbulpore.</i> | 36. | Crown Book Depot, East St. |
| <i>Kanūchi.</i> | 37. | Aero Stores, Napier Road. |

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PREFACE

THE HISTORY AND WORK OF THE SURVEY OF INDIA.

The first authoritative map of India was published by D'Anville in 1752, when the exploration of the then unknown India was still largely in French hands. It had been compiled from routes of solitary travellers and rough charts of the coast.

The Survey of India may be said to have been founded in 1767—ten years after the battle of Plassey—when Lord Clive formally appointed Major James Rennell, the first Surveyor General of Bengal, at that time the most important of the East India Company's possessions, though there were earlier settlements in Madras and Bombay.

Rennell's maps were originally military reconnaissances and latterly chained surveys based on astronomically fixed points, and do not pretend to the accuracy of modern maps of India based on the rigid system of triangulation commenced at Madras in 1802 and since extended over and beyond India. Even now however the *relative* accuracy of these old maps makes them valuable in legal disputes, as for instance in proving that the holding of a Bengal landowner was a river area at the time of the Permanent Settlement of 1793, so that he is debarred from its benefits.

From these beginnings, this department has gradually become primarily responsible for all topographical surveys, explorations and the maintenance of geographical maps of the greater part of Southern Asia, and also for geodetic work.

Geodesy means the investigation of the size, shape and structure of the earth, and the geodetic work of the department consists of primary (or geodetic) triangulation, latitude, longitude and gravity determinations. From these the exact "figure" of the earth is obtained, whereby points fixed by triangulation can be accurately located on its curved surface. This system of fixed points holds together all topographical and revenue surveys, and the existence of such a system from the early days of the department has avoided the embarrassments caused in other countries where isolated topographical surveys have been started without a rigid framework, with the inevitable result that they could not be fitted together.

A geodetic framework is therefore essential in any large survey, but there are a number of other activities, all of these ultimately utilitarian, which can be suitably combined with it and the following are some of those which have been carried out in India:

Precise levelling for the determination of heights;

Tidal predictions and publication of Tide-Tables for thirty-nine ports between Suez and Singapore;

The Magnetic survey;

Observation of the direction and force of gravity;

Astronomical observations to determine latitude, longitude and time;

Seismographic and meteorological observations at Dehra Dūn.

Indian geodesy has disclosed widespread anomalies of the gravitational attraction in the earth's crust which have recently led to a reconsideration of the whole theory of isostasy. Systematic gravity investigations, which may be said to have been initiated in India, are now being carried out intensively in all civilized countries.

Topographical Surveys.—In the past this department used to carry out the large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma in 1905.

Though revenue survey is primarily a record of individual property boundaries and is unconcerned with the surface features, ground levels and exact geographical position essential to a topographical survey, it was on the whole found economical to carry out both surveys together.

By 1905 however, the small scale topographical surveys compiled from the large scale revenue maps had fallen seriously in arrear, owing to the relatively slower pace and incompleteness of the latter, on which "waste" non-revenue-paying areas are normally shown blank.

An authoritative Survey Committee appointed by the Government of India considered the position in 1905. It was feared that a separation of the topographical and revenue surveys might result in a wasteful duplication of work and two overlapping but mutually discrepant systems of mapping. These objections were met by a ruling that the basis of both systems of survey should be identical and provided either by the Survey of India or under its supervision.

Subject to this principle, the remaining revenue surveys were handed over to the provinces, who had always paid for them as part of the overhead charges of revenue collection, and the Survey of India was enabled to concentrate its energies on a complete new series of modern topographical maps in several colours on the 1-inch to 1-mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hill features by contours, proper classification of communications and—more recently—air traffic requirements.

It was intended that the survey begun in 1905 should be completed in twenty five years, and then revised periodically every thirty years. Owing however to the war and more recent retrenchments, only about three fourths of the programme had been completed by 1939, in spite of the reduction of scale for the less important areas.

Although new surveys are carried out every year, covering from thirty to sixty thousand square miles—an area roughly that of England—the maps of a large part of the country are still over 50 years old, printed mostly in black only, and have hill features shown by roughly sketched form lines or hachures; such changes in town sites, canals and communications as have been embodied in them have not been surveyed on the ground, but are entered from data gathered from outside sources.

Owing to the serious financial situation in 1931, the establishment of the department was severely cut down and its annual expenditure halved, in consequence of which the modern survey of India cannot now be completed before 1950.

The obsolescence of the present series of modern maps of India is shown in Index B at the end of this report.

Large Scale Surveys.—Surveys and records of international, state and provincial boundaries have always formed an important item of topographical work, and in recent years numerous Guide Maps have been published of important cities and military stations where the 1-inch to 1-mile scale is inadequate.

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F. Carte Internationale du Monde, 1:M scale	"
G. Southern Asia Series, 1:2M scale	"

GLOSSARY.

Scales are referred to as follows:—

- (i) for scales which are multiples of $1/1,000,000$ —"1/M scale", "1/6M scale" &c., which mean "1/1,000,000 scale", "1/6,000,000 scale" &c.,
- (ii) for scales smaller than 4 miles to one inch—"50-mile scale", "8-mile scale" &c., which mean "scale of 50 miles to one inch", "scale of 8 miles to one inch" &c.,
- (iii) for scales of and larger than 4 miles to one inch—"½-inch scale", "¼-inch scale", "4-inch scale", "16-inch scale" &c., which mean "scale of ½ inch to one mile" &c., &c.
- (iv) Other scales, by their representative fraction, e.g. "1/25,000".

Serial numbering of Survey of India maps.

- Sheets 65, 78 &c. are sheets on the 1/M scale;
- Sheets 65 K, 78 F &c. are ½-inch sheets;
- Sheets 65 K/N.W., 78 F/S.E. &c. are ¼-inch sheets;
- Sheets 65 K/1, 78 F/16 &c. are 1-inch sheets.

The system of numbering is fully explained in the Indexes at the end of this report.

Abbreviations.—U. S. S. denotes Upper Subordinate Service.

L. S. S. denotes Lower Subordinate Service.

U. S. Officer denotes Upper Subordinate Officer.

L. S. Officer denotes Lower Subordinate Officer.

P. L. O. denotes Photo.-Litho. Office (Calcutta).

P. Z. Section denotes Photo.-Zinco Section (Dehra Dūn).

D. O. denotes Drawing Office.

F. O. U. O. denotes "For Official Use Only".

SURVEY OF INDIA

GENERAL REPORT

1939

From 1st October 1938

To 30th September 1939

INTRODUCTION AND SUMMARY.

1. Annual Reports are now published in two separate volumes namely:—

The Geodetic Report.

The General Report.

These reports cover the survey year, which ends on 30th September, except that *Part 4* (Map Publication and Office Work) of the latter is for the financial year, which ends on 31st March.

The *Geodetic Report* contains full details of all scientific work.

The *General Report* includes an abstract of the *Geodetic Report* (in *Part 2*), and full details of the survey operations of the ordinary field units (*Part 3*) as well as drawing, map publication, and instrument manufacture (*Part 4*). Abstracts II and IV (vide Table of Contents) summarize the detailed reports of *Part 3* and enable the reader to select those which are of special interest to him.

The progress of "modern" (i.e. since 1905) topographical surveys made by this Department, and of compilations made from our own or other material, is illustrated in *Index A* at the end of this report, while *Index B* indicates the obsolescence of modern surveys. The remaining indexes show all the standard maps which have been published up to date on the various scales. It will be seen from *Index C* that the areas within the Indian Empire which are blank on *Index A* are actually almost entirely covered by topographical maps. These maps are however from material based on the old longitude of 1815, which was over 2 miles in error, and are drawn in the old style; they are consequently excluded from *Index A*.

2. General.—BRIGADIER C. G. LEWIS, O.B.E., held the post of Surveyor General, throughout the year. COLONEL E. O. WHEELER, M.C., officiated from 6th March 1939 to 14th May 1939 and COLONEL L. H. JACKSON, I.A., from 15th May to 28th September 1939, while BRIGADIER LEWIS was on leave.

The post of Assistant Surveyor General was held by MAJOR G. F. HEANEY, B.E., throughout the year.

3. The total cost of the Department for the year ending 31st March 1939, as compared with that of previous years, was as follows:—

	1936-37	1937-38	1938-39	REMARKS.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>	
Gross actual cost ...	35,66,128(a)	37,91,805(b)	35,04,975†	(a) Including Rs. 83,272 for English Charges (High Commissioner) on Stores, and loss or gain by exchange.
Deduct recoveries ...	10,60,863	12,90,070(c)	14,32,043	(b) Including Rs. 71,001 for do. do. and Rs. 1,88,646 for sterling oversens pay and leave salary &c. paid in England.
				(c) The increase in recoveries is due mainly to the entire cost of surveys in Burma having been paid for by that country since 1-4-37.
Nett actual charges ...	25,05,265	25,01,726	20,72,932†	† These figures are not final.
Total area of survey of all kinds completed during the year.	Square miles.	Square miles.	Square miles.	* Vide page 15
	87,670	88,559	23,558*	

4. Organisation.—The headquarters of No. 1 Party were transferred from Mussoorie to Dehra Dūn from 11th November 1938 and those of 'E' Company from Quetta to Karāchi from 1st April 1939.

The Government of India, Defence Department, have sanctioned the permanent addition of one British other rank to the establishment of the Army Section of No. 6 Drawing Office with effect from 1st August 1938 raising the number of European Draftsmen from 6 to 7.

The Government of India have sanctioned the grant of a special pay of Rs. 50 (rupees fifty) per mensem to the Class II service Officer in Charge of the Drawing Section of the Burma Survey Party with effect from 1st July.

5. Noteworthy events of the Survey year.—

Air Surveys.—No. 5 Party carried out the contouring at 5-foot intervals of about 10 square miles of the area round Jamshedpur of which a 16-inch Air Survey Map had been prepared last year.

A detachment of No. 4 Party completed the fair drawing of the 16-inch air survey map of Bettiah Town and its immediate vicinity, comprising 4 sheets. The total area surveyed covered approximately 10 square miles and comprised all the area within municipal limits with an overlap of about half a mile all round.

The sheets were drawn for publication in colours but without contours. In lieu of the latter, spot levels were fixed throughout the area surveyed and the heights obtained appear on the published sheets.

The inking up of detail only, on rectified blue-toned enlargements on correctostat paper, enabled blue prints to be prepared by direct photography and was similar to the method employed in the Air Survey of Nāgpur and Jamshedpur.

Military Training and Survey Exercise.—Military training, beginning with individual training and ending with a combined exercise in which the R. A. Survey Section and other R. A. units took part, was carried out by 'A' Company assisted by No. 18 Party during October to December 1938.

LIEUT.-COLONEL E. O. WHEELER, M.C., and MAJOR D. R. CRONE, R.E., were members of the Directing Staff for the combined exercise which took place between November 28th and December 3rd 1938.

Special surveys.—Rectangulation, Levelling and 4-inch survey were conducted by 'A' Company in the Sirsa Tahsil of the Hissār District as a basis for planning a canal system for relief of the area which is peculiarly subject to famine. This forms part of the "Bhakra Dam Project".

Survey operations in Sikkim State.—The triangulation of Sikkim State which was started on 7th September 1938 by LIEUT. L. H. WILLIAMS, R.E., and MR. A. AHAD (Class II) of No. 12 Party, was continued by CAPTAIN R. H. SAMS, R.E., and MR. A. AHAD. The party returned to Shillong in December 1938, and MR. A. AHAD returned again to Sikkim in March 1939.

In August 1939, the plane-table survey of Sikkim on $\frac{3}{4}$ -inch scale was started. The work is expected to be completed by April next year.

Conferences.—The Surveyor General held a conference with all the Directors of the Survey of India at New Delhi from 2nd to 6th January 1939 to discuss the policy of decentralisation of map maintenance, the simplification of reproduction of maps by reduction in the number of colours, and to evolve technical methods for the $\frac{3}{4}$ -inch compiled mapping on which the field personnel of the Department are to be employed during the next two years. LIEUT.-COLONEL W. J. NORMAN, M.C., R.E., also attended the conference.

MR. R. C. MALCOLM, Superintendent, Mathematical Instrument Office, conferred with officers in Army Headquarters and the Defence Co-ordination Department and with the joint Secretary, Department of Education, Health and Lands, at Simla in July 1939. He also visited the Ordnance Workshops at Rāwalpindi.

While at Simla, MR. MALCOLM discussed, at the request of the Chief Inspector of Lighthouses for India, the problem of measuring sway in Lighthouses and the construction of suitable apparatus for this purpose.

Lecture.—At the request of the Brigade Commander, Sind Brigade Area, CAPTAIN D. E. O. THACKWELL, R.E., delivered a lecture on the 12th August 1939 to officers in Karāchi on "Map Production".

6. Explorations.—MESSRS. F. LUDLOW and G. SHERRIFF's route report and sketches of their journey in Tibet in 1938, falling in 4-inch sheets 82 H, K and L, have been received and entered as office copy corrections.

The results of the German Expedition to Szechwan (China) in 1913-14, as published in the Petermanns Geographische Mitteilungen, 1938, are being incorporated in 1/2 M Yunnan sheet.

Surveyors FAZAL ELAHI and INAYAT KHAN accompanied Mr. ERIC SHIPTON on an expedition to the Karakoram. The results of the expedition will be published in next year's report.

Miscellaneous.—MESSRS. J. A. CABRAL and A. G. QURESHI, Sub-Assistant Superintendents were transferred on foreign service with MESSRS. ANDREW YULE & Co., LTD., for a period of about two years with effect from the 5th January 1939.

7. Adventures and Casualties.—The Surveyor General deeply regrets to record the following deaths:—

SUBEDAR-MAJOR and HONORARY LIEUTENANT KISHEN SINGH, M.B.E., I.D.S.M., I.M.D., who died of Coronary Thrombosis in the Indian Military Hospital, Dehra Dūn on the 5th December 1938.

16 Lower Subordinates and 14 inferior servants died during the year under report.

SURVEYOR MANAWAR KHAN was shot and dangerously wounded by tribesmen while employed in the revision of the Razmak 3-inch map.

8. Distinguished visitors.—The General Officer Commanding-in-Chief, Northern Command inspected No. 1 Field Survey Company on the 8th November 1938, during the course of individual military training.

AIR MARSHAL SIR PHILIP B. JOUBERT DE LA FERTÉ, K.C.B., C.M.G., D.S.O., Air Officer Commanding-in-Chief, Air Forces in India and Wing COMMANDER B. ANKERS, D.S.O., D.C.M., Commanding No. 2 Wing Station, Royal Air Force visited the offices of No. 18 (Air Survey) Party at Risālpur on 14th April 1939.

MR. H. H. CRAW, C.I.E., I.C.S., and MR. H. O. REYNOLDS, C.M.G., I.C.S., successively Financial Commissioners to the Government of Burma, visited the offices of the Burma Survey Party in Maymyo in October 1938 and May 1939 respectively.

MR. K. P. SAGREIRA, Silviculturist to the Forest Department of the Central Provinces visited the offices of the Geodetic Branch on the 8th October 1938 in connection with the work of the Forest Map Office for the Government of that Province.

DR. A. O. RANKINE, O.B.E., Geophysical Consultant to the Burma Oil and Anglo-Iranian Oil Companies visited the Geodetic Branch Office, Dehra Dūn on the 17th February 1939.

9. Awards.—His Excellency the Viceroy has been pleased to confer the title of Rai Sahib, as a personal distinction, upon Mr. MAHENDRA NATH CHOUDHURI, Chief Supervisor, Mathematical Instrument Office.

SUB-CONDUCTOR J. G. WILSON, Draftsman, Army Section, No. 6 Drawing Office has been awarded the Long Service and Good Conduct Medal without gratuity.

10. Mathematical Instrument Office.—A new type of offset scale in plate glass, with the scale engraved on the underside, and ten offset sighting instruments were made for the Lahore Survey Detachment.

One 48-inch Research Calliper which is to be used in measuring the diameters of trees was designed and manufactured for the Provincial Silviculturist, Ootacamund.

Four special chains, steel band crinoline, .125" wide, 106 feet long, were manufactured and supplied to the Officer in charge, Lahore Survey Detachment.

227 sets of Hydrometers, pocket, brass, for excise purposes, in box complete with 10 weights, mag. glass, thermometer and test jar and 227 sets of grain weights with tweezers in teak wood boxes, were manufactured for the Commissioner of Excise and Salt, Bengal, for use by the Excise Officers inspecting drug shops.

A coordinatograph has recently been constructed which incorporates a number of new ideas.

The instrument is designed to plot and make measurements over an area of 46 inches \times 30 inches. It is also designed for use with 4 scales, viz. 1 inch and $1\frac{1}{2}$ inches to the mile, $1/25,000$ and $1/50,000$. When working on any of these scales measurements can be made direct in yards and no conversion is necessary.

- 11. Personnel.—Casualties, retirements, promotions and other changes were as follows:—

Class I Officers.—COLONELS J. D. CAMPBELL, D.S.O., and F. J. M. KING, and MESSRS. C. H. TRESHAM, V.D., D. K. RENNICK, M.B.E., and J. MCCRAKEN, M.B.E., retired.

COLONEL F. B. SCOTT, I.A., and MR. M. M. MUDALIAR, M.A., granted leave preparatory to retirement.

BT.-COLONEL L. H. JACKSON, I.A., and LT.-COLONELS E. O. WHEELER, M.C., and O. SLATER, M.C., confirmed as Director and promoted to Colonel.

CAPTAINS C. A. K. WILSON, R.E., and R. C. N. JENNEY, R.E., promoted to Superintendent.

CAPTAIN GURDIP SINGH, I.A., reverted to military duty. LIEUTENANTS R. A. GARDINER, R.E., GAMBHIR SINGH, I.A., and RAJINDER SINGH KALHA, I.A., promoted to Captain.

CAPTAIN R. A. GARDINER, R.E., and LIEUT. R. C. A. EDGE, R.E., confirmed as Assistant Superintendent.

MESSRS. A. J. A. DRAKE, D.C.M., and F. H. GRANT promoted to Superintendent.

Class II Officers.—RAI SAHIB R. B. MATHUR, B.A., retired.

MR. TIRLOCHAN SINGH, C.E., resigned

MESSRS. S. C. CHATTERJEE, B.Sc., and A. K. SEN GUPTA, C.H., promoted from Upper Subordinate Service to Class II.

Eight officers were appointed to the Class II Service, on probation.

General Central Service (Class II).—MR. S. COLQUHOUN, granted leave preparatory to retirement.

RAI SAHIB G. M. DHARA, retired.

MR. F. E. SELFE, ceased to be in the employ of the Survey of India on termination of his contract.

MR. D. C. VERMA, Officiating Registrar, confirmed in his appointment.

Upper Subordinate Officers.—MR. MUHAMMAD MUZAFFAR SHAH,
retired.

Surveyor MANAWAR KHAN, promoted to the Upper Subordinate
Service.

Five probationers, confirmed.

II. ABSTRACT OF SURVEYS IN EACH PROVINCE AND STATE.

12. The primary survey duties of the Survey of India are geodetic, topographical, and geographical, but the department is also developing co-operation with local survey agencies, with a view to mutual economy, and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting Provincial Governments with local and settlement surveys as required.

The following abstract shows the nature and localities of the field operations carried out by the department during the past year, grouped under the following sub-heads:

Air Surveys.	Geodetic.
Boundary Surveys.	Levelling.
Cantonment and City Surveys.	Miscellaneous.
Exploration.	Special Surveys.
Forest Surveys.	Topographical Surveys.
Framework.	Training.

If a province or state is not mentioned, no work has been done there during the year under report.

13. Baluchistān.

Topographical surveys in Kalāt and Las Bela States (p. 40).

14. Baroda.

Framework. Traverse in Mehsāna district (p. 47).

15. Bengal.

Levelling. Secondary levelling (one leveller taking 2 sets of observation at each station) for Calcutta Corporation in connection with Dr. Dey's Kulti out-fall scheme (p. 61).

Topographical surveys in Chittagong district and Chittagong Hill Tracts (p. 53).

16. Bihār.

Topographical surveys in Champāran, Darbhanga and Muzaffarpur districts (p. 50).

17. Bombay.

Air survey in Poona district (p. 42).

Framework. Triangulation and traverse in Ahmadābād, Brāach and Pānch Mahāls, and Kaira districts (p. 47). Triangulation in Belgaum and Sātara districts (p. 56). Traversing for fixing the position of the wireless mast in the compound of the office of the Director General of Observatories, Poona (p. 48).

Topographical surveys in Belgaum and Bijapur districts (p. 56).

18. Central India.

Topographical surveys in Dewās (senior), Dewās (junior), Dhār, Indore, Jaora, Jhābua, Piploda, Ratlām, Sailāna and Sitamau States (p. 46). Resurvey for a special military map of Bhopāl city (p. 47).

19. Central Provinces and Berār.

Framework. Triangulation in Chānda district (p. 51).

Levelling. High precision levelling for the new geodetic level net in the back direction from Sohela to Pathora part of line Raipur to Bhadrakh (p. 13).

Topographical surveys in Raipur district (p. 52).

20. Deccan States.

Air survey in Bhōr State (p. 42).

Framework. Triangulation in Jamkhandi, Jath, Kurandvād (senior), Kurandvād (junior), Miraj (senior), Miraj (junior), Sāngli and Sāvantvādi States (p. 56).

Topographical surveys in Aundh, Jamkhandi, Jath, Kurandvād (senior), Kurandvād (junior), Mudhol, Rāmdurg and Sāngli States (p. 56).

21. Delhi.

Air survey (p. 42).

Cantonment and city surveys. Supplementary town survey (p. 48).

22. Eastern States.

Framework. Triangulation in Bastar State (p. 51).

Levelling. High precision levelling for the new geodetic level net in fore direction from Pāl Lahara to Bhadrakh, part of line Raipur to Bhadrakh and Bhadrakh to Balasore part of line Howrah to Bhadrakh (p. 13).

Topographical surveys in Kālāhandi and Patna States (p. 52).

23. Gujarāt States.

Framework. Triangulation and traverse in Bālāsīnor and Lūnāvāda States (p. 47).

24. Gwalior.

Miscellaneous. Determination of geographical position of wireless telegraph stations near Lashkar (p. 47).

Topographical surveys in Mandasor, Shājāpur and Ujjain districts (p. 46).

25. Kashmīr and Jammu.

Topographical surveys in the Karakoram (p. 38) and in Kashmīr and Jammu (p. 37).

26. Kolhāpur State.

Framework. Triangulation.

Topographical surveys.

27. Madras.

Levelling. High precision levelling for the new geodetic level net in fore direction from Bhadrakh to Vizianagaram with branch line from Cuttack to False Point (p. 13).

Topographical surveys in Nilgiri district (p. 56).

28. N. W. F. Province.

Air surveys in Dir, Swāt and Chitrāl and North and South Waziristān Agencies (p. 42).

Cantonment and city surveys. Survey and resurvey of Kohāt Cantonment (p. 48).

Framework. Traversing and levelling, Cantonment survey of Bannu, Cherāt, and Dera Ismāil Khān and Fort Akalgarh and extension of part of Kohāt Cantonment (p. 48).

29. Orissa.

Levelling. High precision levelling for the new geodetic level net in the back direction from Sohela to Pathora part of line Raipur to Bhadrakh and in the fore direction from (i) Pāl Lahara to Bhadrakh, part of line Raipur to Bhadrakh (ii) Bhadrakh to Balasore, part of line Howrah to Bhadrakh and (iii) Bhadrakh to Vizianagaram with branch line Cuttack to False Point (p. 13).

Topographical surveys in Sambalpur district (p. 52).

30. Punjab.

Air survey in Gurgaon (p. 42).

Cantonment and city surveys. Resurvey of Siālkot Cantonment (p. 48). City surveys in the Murree Hills (p. 39) and in the Urban areas of Lahore (p. 44).

Framework. Traversing and levelling for cantonment survey of Dalhousie, Jhelum and Jullundur Cantonments (p. 48). Traversing of Bakloh Cantonment (Rifle Range) boundary (p. 48). Triangulation and traverse in the Murree Hills (p. 39). Rectangulation in Hissār district (p. 39).

Levelling in Hissār district (p. 39). Double and single tertiary levelling in Hoshiārpur and Jullundur districts for Punjab Irrigation Works (p. 61).

Special surveys in Hissār district (p. 39).

31. Punjab States.

Levelling. Double and single tertiary levelling in Kapūrthala State for Punjab Irrigation Works (p. 61).

32. Rājputāna.

Topographical surveys in Bānswāra, Jhālāwār, Kushālgarh, Partābgarh and Udaipur (Mewār) States (p. 46).

33. Sikkim State.

Framework. Triangulation in Sikkim State (p. 53).

Topographical surveys in Sikkim State (p. 54).

34. Sind.

Cantonment and city surveys. Survey of Drigh Road Cantonment (p. 48).

Framework. Triangulation in Dādu district (p. 42).

Topographical surveys in Dādu district (p. 41).

35. States of Western India.

Boundary survey. Boundary demarcation between Morvi and Cutch States (p. 46).

Framework. Triangulation and traverse in Amliyāra, Dābha, Idar, Gābat, Magori, Mālpur, Mohanpur, Ramās, Ranāsan, Rupāl, Varāgām and Sāthamba States (p. 47).

36. United Provinces.

Framework. Traversing of part, Allahābād and Cawnpore Cantonment boundaries (p. 48). Traversing of Ambāri Tea Estate, Dehra Dūn extra-departmental "paid for" work (p. 48).

Geodetic. Gravity observation at Dehra Dūn with apparatus on loan from Cambridge University (p. 12).

Topographical surveys in Almora district (p. 45).

BURMA.

37. Forest surveys in Tharrawaddy district (p. 59).

Framework. Triangulation and traverse in Henzada, Prome, Tharrawaddy and Toungoo districts (p. 59).

Geodetic. Gravity observations at 42 stations and repeat observation at one station (p. 12).

Topographical surveys in Henzada, Kyaukse, Mandalay, Pegu, Prome, Sagaing, Tharrawaddy and Toungoo districts (p. 59) and in the Northern Shan States (p. 60).

PART 2.—GEODETIC WORK.

III.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:—{Colonel E. O. Wheeler, M.C., to 28-2-39.
 {Lt.-Colonel E. A. Glennie, D.S.O., from 1-3-39.

38. General.—Besides geodetic work, the Director, Geodetic Branch administers at Dehra Dūn *No. 2 Drawing Office*, the *Forest Map Office*, a *Printing Section* and a *Photo-Zinco. Section*, whose work is reported in Part 4 of this report, and also the following survey operations, which are reported in other parts of the General Report:—

Topographical Survey carried out by No. 1 Party (paras. 79—83).

Cantonment Surveys (paras. 84—88).

Training School (para. 130).

39. Geodetic.—Purely geodetic operations include miscellaneous computations and research, preparation and publication of records, observatory work (astronomical, magnetic, seismological and meteorological), the measurement of geodetic bases, principal triangulation, geodetic levelling, precise latitudes, longitudes, azimuths, gravity determinations in all parts of India and Burma and prediction of tides at 39 ports between Suez and Singapore.

These operations are fully described in the annual Geodetic Report of the Survey of India which contains complete index maps and detailed results. The following is a brief abstract of the geodetic operations described in the Geodetic Report of 1939.

40. Observatory Section.—The usual magnetic, seismographic and meteorological observations have been carried on, the longitude observations have been discontinued, as no systematic variation has been discovered in the 12 years during which they have been carried out, and they now only serve to record personal equations and the imperfections of the instruments.

The latitude variation programme at Agra was continued for its second year, and the results confirm the large variation obtained in the first year.

41. Computing Section.—In 1914 a start was made with the publication of all triangulation data, geodetic and topographical, in the form of a series of triangulation pamphlets each covering a degree square. It was then premature to include the topographical triangulation as much was still to be observed, and consequently only G. T. data were printed in the pamphlets, except in those for frontier and transfrontier areas. Now that the topographical triangulation of much of India is complete, a fresh start has been made on the publication of complete data pamphlets. It is hoped to issue the first pamphlet of the new series in 1940.

Hayford anomalies have been computed at 400 latitude, longitude and azimuth stations during the year.

Gravity anomalies on the hypothesis of regional compensation have been computed at all Indian gravity stations by the method described by Dr. F. A. Vening Meinesz in No. 29 of 1931.

The main triangulation of the Lahore Survey Detachment was computed and adjusted and that of the Murree survey computed.

Assistance has been given to the Burma Oil Company for the computation of gravity anomalies in areas in which they are undertaking geological prospecting in the field.

Assistance has also been given to No. 14 Party in the computation of its field work as usual.

The following publications were seen through the press:—

- (1) Geodetic Report 1938.
- (2) Levelling Pamphlet 41.
- (3) Auxiliary Tables Part II (reprint).
- (4) Report to the International Union of Geodesy and Geophysics on the Geodetic work of Survey of India for the period of 1933-39.

42. Tidal Section.—The tide-tables of the Indian Ocean for 1940 for 67 ports were prepared and published in September 1939. Predictions for Kārwār and False Point have been discontinued while Navlakhi on the Gulf of Cutch has been predicted and included in the tide-tables for the first time.

Automatic tidal registrations were continued at Aden, Karāchi, Bombay, Vizagapatam, Dublat, Calcutta and Rangoon. Owing to the reconstruction of the pier on which the Aden gauge is situated, it was found necessary to reject its readings from 1st August 1938 to June 1939. In addition, tide pole readings of high and low water, during daylight only, were continued at Bhaunagar, Chittagong and Akyab.

43. Latitude and Longitude.—(No. 14 Party).—About six months' work remains to complete gaps in the deflection programme in the north-west of India and in Bengal. It was proposed to undertake this work during 1938-39, but owing to financial stringency it was unfortunately found necessary to postpone it; it is hoped to complete it in 1939-40.

44. Gravity Observations.—(No. 14 Party).—Observations to determine the force of gravity were made at 42 new stations in Burma. One old station in Burma was reobserved in the middle of the programme and again at the close. The observer was Mr. M. N. A. Hashmie (Class II).

In the Shan States transport was by two hired motor lorries, and in the Chin Hills by coolie. In the rest of Burma journeys were made, at times with some difficulty, by steamer, launch, rail, motor lorry and car. All gravity stations in India and Burma show the force of gravity relative to that at Dehra Dūn. By the kindness of Sir Gerald Lenox-Conyngham, F.R.S., the Cambridge apparatus was lent for the purpose of redetermining the value of gravity at Dehra Dūn relative to Potsdam. Observations were taken at Cambridge, where the value of gravity relative to Potsdam is known. The apparatus was then sent to Dehra Dūn, where a series of

observations were taken in April-May. Further observations at Cambridge in July checked the stability of the pendulums. Results are not yet available.

45. Geodetic Traverse.—(No. 15 Party).—On account of financial stringency the geodetic traverse could not be taken up in 1938-39 but it is hoped to commence work on it in the 1939-40 season.

46. High Precision Levelling.—(No. 15 Party).—Out of the total length of 15,800 miles of levelling of high precision required for the new geodetic level net of India, 61 miles were completed during 1938-39, by levelling in back direction from Sohela to Pithora, making a total of 10,084 miles completed up to date.

During 1938-39, 610 miles of single levelling for the new geodetic level net were also carried out in the fore direction from (i) Pāl Lahara to Bhadrakh part of line Raipur to Bhadrakh (ii) Bhadrakh to Balasore part of line Howrah to Bhadrakh and (iii) Bhadrakh to Vizianagaram with branch line from Cuttack to False Point.

Secondary and Tertiary Levelling.—Report will be found under Section IX of this Report (p. 61).

Note.—Figures of mileage are preliminary only.

PART 3.—TOPOGRAPHICAL WORK.

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

47. The following tables indicate the progress achieved to date in the topographical survey programme assigned to the Department in 1905 and give details of the work done in the year under report.

Table A shows the area of survey completed on various scales since 1905, as well as the approximate balance which remains to complete the contoured topographical survey of India. The figures which were entered in the report for 1930-31 were found on re-examination to be inaccurate, and to be incapable of calculation by 5 year periods for separate scales; consolidated figures from 1905 to 1935 are therefore given. These figures also include the area of survey work done in Burma prior to separation. Now however that Burma has been separated from India, though the Survey of India will continue to survey Burma for some time to come, the work there will no longer form part of its functions as a department of the Indian Government. The total areas of survey work in India and Burma have therefore been shown separately.

Table B shows the area revised during the year under report.

Table C shows in detail the survey operations carried out during the year under report, together with their cost rates. While every attempt is made to calculate the cost rates accurately, it is extremely difficult to allocate "overhead charges" fairly to the various classes of work, and rates of pay etc., will vary with the locality; the cost rates shown in the table must therefore be considered to be approximate. For this reason, a column showing "out-turn" is included in the table, which those familiar with survey organization will find very useful in estimating costs in subsequent years.

The costs, shown for mapping and computations are those incurred in the party etc., offices only, except where otherwise stated; publication charges, if required, may be ascertained from the Director, Map Publication, at Calcutta.

48. **Progress.**—In the second page of the preface to this report will be found a brief outline of the scope of the topographical surveys of the department. The hopes expressed in 1905—that modern maps on the 1-inch scale would be available for the entire Indian Empire within 25 years—are still far from realization in 1939, rather over half the total area of India having been completed on that scale. In 1913, when it was realized that for various reasons it would be impossible to complete the 1-inch surveys in the time allotted, a scheme for the reduction of the scale of survey in the less populous areas was sanctioned by the Secretary of State.

In spite of the reductions in scale however, only about three fourths of the country is as yet covered by modern maps. The tendency to revert to the 1-inch scale in special circumstances, such as in areas of more than ordinary military, geological or engineering importance, the necessity which frequently arises to resurvey on the 1-inch scale areas already surveyed on smaller scales as they grow in importance, the need for the comparatively frequent revision of existing surveys in the

more populous areas and lastly but by no means least important, the recent urgent necessity for economy: all these factors have conspired to delay still further the completion of the programme even as amended in 1913.

Original surveys in India since 1931, the year of retrenchment, have been carried out at the rate of about 36,000 square miles per annum; on this basis, some 12 years are still required to complete the programme.

The average out-turn for Burma has been about 4,500 square miles and the area remaining for survey is 55,953 square miles which represents at above rate another 12 year's work.

The present position of the mapping of India is shown in the first two *Index Maps* at the end of this volume.

Table A.—Progress of Topographical Surveys in India since 1905.

Survey years.			1-inch and larger scales.	$\frac{1}{2}$ and $\frac{1}{4}$ -inch scales.	$\frac{3}{8}$ and $\frac{1}{8}$ -inch scales.	TOTALS.
			<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
1905—35	...	...	848,629	189,084	25,929	1,063,642
1935—38	...	...	40,262	48,726	19,019	108,007
1938-39	...	...	9,250	10,120	849	20,219
Totals to 1939			898,141	247,930	45,797	1,191,868
<i>Balance</i>			approximately. 170,000	approximately. 160,000	approximately. 100,000	431,147
Total programme			.....	.....	.....	1,623,015*

* Revised figures, due to corrected area of sheet 62 B, and to change in sea limits.

Progress of Topographical Surveys in Burma since 1905.

1905—35	...	...	146,208	41,634	.....	187,842
1935—38	...	...	12,974	2,379	.....	15,353
1938-39	...	...	2,572	.....	.....	2,572
Totals to 1939			161,754	44,013	.....	205,767
<i>Balance</i>			.....	.....	.....	55,953
Total programme			.....	.....	.....	261,720

Table B.—Revision and Resurvey of above work during the year.

India 1938-39	...	238	27	333	598
Burma 1938-39	...	199	.....	.....	199

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
FRONTIER CIRCLE.								
'A' Company.—				Sq. m.	Sq. m.	Rs.	Rs.	(a) The area done is a test area only and figures are not given, as these would be misleading.
Medium wooded hills	... 40 feet to 1 inch.	43 G	15	(a)	(a)	(a)	.....	(b) Includes computation and preparation of fair charts.
Steep hills	... 40 feet to 1 inch.	43 G	4.1 linear miles.	(a)	(a)	(a)	.....	(c) No out-turn can be given as the work was just started.
Sandy plains	... 4-inch Rectangulation	44 K	111	0.97	47	.....	47	(d) Includes preparation of p. T. Section for reproduction and preparation of contour charts.
Ditto	... 4-inch Levelling	44 K	111	2.85	52(a)	Nil	52	
Medium wooded hills	... 40 feet to 1 inch.	43 G	12 acres.	(c)	(a)	(a)	.....
Sandy plains	... 4-inch Special survey	44 K	102	7.18	48(a)	.....	48	

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
FRONTIER CIRCLE.— <i>Contd.</i>								
'E' Company.—				Sq. m.	Sq. m.	Rs.	Rs.	Rs.
Low barren hills	1-inch	40 B, C	...	321.1	653	7.0	1.4	8.4
Barren hills and plain	1-inch	35 O	...	238.4	1,073	4.4	1.6	6.0
High intricate hills, sandy plain and sand hills.	1-inch	35 K	...	53.9	2,690	18.9	(a)	.....
Low barren hills	1-inch	40 B, C	...	19.7	547	(b)	(b)	.....
Ditto	1½-inch	40 C	...	6.6	119	(b)	(b)	.....
Open plain with a few houses	4-inch	35 L	...	17.5	7	16.0	.....	.....
Fair mapping	1-inch	35 O	...	.....	1,073	(c)	(d)	.....
	3-inch	Karachi Guide Map.	83	.....	(c)	(c)	79.5	.....
	1/4M	Sind Province Map.	53,870	.....	.....	.....	(b)	.....
			Approx.					

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos. or Locality.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or compu- tations.	Total.	
No. 18 (Air Survey) Party.—								
Broken hills (3,000 to 7,000 feet).	1-inch Original air survey	38 L ...	75	Rs. (Air survey compila- tion). 109'6	Rs.	FRONTIER CIRCLE.— <u>Contd.</u>
Steep partly wooded mount- ains and broken hills (3,000 to 8,000 feet).	1-inch Original air survey	Tribal territory	12	.....	78'4	.....	.....
Steep partly wooded mount- ains and broken hills (3,000 to 10,000 feet).	1-inch Original air survey	Ditto	17	.....			
Broken ground (700 to 1,000 feet).	1/25,000 Original air survey	53 H ...	124	.....	4'3	.....	.....
Low hills ...	1/25,000 Original air survey	47 F ...	81	.....			
Steep partly wooded mount- ains and broken hills (3,000 to 10,000 feet).	1-inch Revision air survey	Tribal territory	104	.....	50'7	.....	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos. or Locality.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.		
					Field work.	Mapping or compu- tations.	Total.			
No. 18 (Air Survey) Party.— <i>Concd.</i>					Sq. m.	Sq. m.	Rs.	Rs.	Rs.	FRONTIER CIRCLE.— <u>Contd.</u>
<i>Sleep partly wooded mount- ains and broken hills (3,000 to 10,000 feet).</i>	1-inch Sketch air survey	Tribal territory	9	.....	(Air survey comple- tion). 95'4	.....	.....	.....
<i>Hilly country (6,000 to 8,000 feet).</i>	3-inch Ground verifica- tion survey.	Ditto	32	.....	90	.....	.....	.....
<i>Fair mapping ...</i>	... ..	38 O & Tribal territory (Ri- gorous edi- tions).	200	2,133	107	.....	.....	.....		Extensive modernization and correction of provi- sional issues were also carried out.
		Tribal territory (Provisional issues).	780	13,351	171	.....	.....	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING FUELS AND MEN UNDER TRAINING.			REMARKS.		
					Field work.	Mapping or computations.	Total.			
Lahore Survey Detachment.—					Sq. m.	Sq. m.	Rs.	Rs.	Rs.	FRONTIER CIRCLE.— <u>Contd.</u> (a) Final figures will not be available till completion of work in 1910.
Mixed areas as below		...	40 feet and Triangulation 100 feet to 1 inch.	.....	32,000 acres.	(a)	(a)	(a)	.....
Ditto		...	40 feet and Traverse 100 feet to 1 inch.	.....	470 linear miles.	(a)	(a)	(a)	.....
Congested areas		...	40 feet to Detail survey 1 inch.	.....	460 acres.	(a)	(a)	(a)	.....
Residential areas		...	40 feet to Detail survey 1 inch.	.....	94 acres.	(a)	(a)	(a)	.....
Open agricultural areas		...	40 feet to Detail survey 1 inch.	.....	646 acres.	(a)	(a)	(a)	.....
Congested areas		...	100 feet to Detail survey 1 inch.	.....	250 acres.	(a)	(a)	(a)	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	Cost rate per Sq. M. (or Acre) of each description of work, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
FRONTIER CIRCLE.—								
<i>Concl'd.</i>								
(a) Final figures will not be available till completion of work in 1910.								
(b) Per 100 square miles.								
Labore Survey Detachment.—								
<i>Concl'd.</i>								
<i>Residential areas</i>	... 100 feet to Detail survey ... 1 inch.	.....	751 acres.	(a)	(a)	(a)	.....
<i>Open agricultural areas</i>	... 100 feet to Detail survey ... 1 inch.	.....	1,803 acres.	(a)	(a)	(a)	.....
No. 6 Drawing Office.—								
<i>Map examination</i>	... 1-inch Sheets	.....	.....	.....	.....	0.5	.....
<i>Ditto</i>	... 1-inch Sheets	.....	.....	.....	.....	0.2	.....
<i>Ditto</i>	... 1/M Province map	.....	.....	.....	.....	0.05(b)	.....
<i>Colour Patterns</i>	... 1-inch Sheets	.....	.....	.....	.....	0.4	.....
<i>Ditto</i>	... 1-inch Sheets	.....	.....	.....	.....	0.08	.....
<i>Ditto</i>	... 1-inch Sheets	.....	.....	.....	.....	0.01	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet No.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING FUELS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or compu- tations.	Total.	
<u>GEODETIC</u> <u>BRANCH.</u>								
No. 1 Party.—			Sq. m.	Sq. m.	Rs.	Rs.	Rs.	
<i>High altitude Himalayas (10,000 feet to 24,000 feet).</i>	1-inch	62 B	1,153	50'0	39'0	5'9	44'9	
<i>Ditto</i>	3-inch	62 B	27	.....	.....	.....	.....
<i>70% undulating plains and cultivation; 30% lightly wooded broken hills.</i>	1-inch	46 I, M	6,277	58'4	7'5	7'6	15'1	
<i>50% undulating plains and cultivation; 30% lightly wooded broken hills; 20% wooded areas.</i>	1-inch	55 E	72	33'4	19'6	.....	.....
<i>Cultivated land with trees...</i>	1-inch	46 E	820	232'8	2'7	.....	.....
<i>Ditto</i>	1-inch	46 E	71'8 linear miles.	57'9 linear miles.	19'9 per linear mile.	.....	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. MI. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
No. 20 (Cantonments) Detachment.—								
<i>Cantonment (Hill). Fairly congested and wooded in parts.</i>	16-inch Triangulation	38 O	2,278	2,440'7	Rs.	Rs.	Rs.	<u>GEODETIC</u> <u>BRANCH.—</u> <u>Contd.</u> Cherit Cantonment.
					0'1	(a)	.....
<i>Cantonments (Plains). Fairly open to average congestion and in parts heavily congested.</i>	18-inch Traverse	38 K, L, 39 I, 43 H, 44 M	11,982	1,344'0	Rs.	Rs.	Rs.	Banna, D. I. Khan, Fort Alkalgarh, Jhelum and Jullundur Cantonments.
					0'4	0'2	0'6	
<i>Cantonments (Hill). 16-inch Fairly open to average congestion, thickly wooded in parts and intersected by nullas.</i>	16-inch Traverse	38 O, 43 P	3,393	665'3	Rs.	Rs.	Rs.	Cherit and Dalhousie Cantonments.
					1'1	0'5	1'6	
<i>Cantonments (Plains). Average congestion and open in parts.</i>	64-inch Traverse	43 H, 44 M	126	315'0	Rs.	Rs.	Rs.	Jhelum and Jullundur Cantonment Bazaars.
					1'9	2'9	4'8	

(a) The cost of computation of triangulation is included in the cost rates of traverse computation.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
No. 20 (Cantonments) Detachment.—<i>Conold.</i>								
<i>Cantonments (Plains). 16-inch Resurvey ...</i> <i>Fairly open to average congestion and 30% very congested.</i>		38 O, 43 L ...	Acres.	Acres.	Rs.	Rs.	Rs.	GEODETIC BRANCH.— <i>Conold.</i> Kohat and Sialkot Cantonments.
					1'8	1'1(a)	2'9	
<i>Cantonments (Plains). 64-inch Original survey ...</i> <i>80% congested and 20% open.</i>		36 P, 38 O ...	24	16'7	Rs.	Rs.	Rs.	Drigh Road and Kohat Cantonment Bazar.
					17'2	17'8	35'0	
<i>Cantonment (Plains). 64-inch Resurvey ...</i> <i>70% congested and 30% fairly open.</i>		40 L ...	170	15'9	Rs.	Rs.	Rs.	Sialkot Cantonment.
					17'4	11'9(a)	29'3	

(a) The areas mapped do not actually correspond to those surveyed but include mapping arrears completed in the period under report.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or compu- tations.	Total.	
No. 4 Party.— <i>Plains, extensively cultivated and thickly populated with fairly abundant tree growth.</i>	1-inch Original survey ...	72 F	2,076	281	Ra. 21'2	Ra. 12'9	Ra. 34'1	<u>EASTERN</u> <u>CIRCLE.</u>
No. 5 Party.— <i>The eastern portion of the area is densely wooded fairly high hills up to 3,000 feet in parallel ranges, the western portion is densely wooded flat low hills and undulations. The whole area is sparsely populated with very poor communica- tions.</i>	1-inch Triangulation	85 A	2,248	234'5	Ra. 5'5	Ra. 1'9(m)	Ra. 7'4	(a) Computation of 673 square miles in hand.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	Cost rate per Sq. M. (or Acre) of each description of work, excluding pupils and men under training.			REMARKS.
					Field work.	Mapping or compu- tations.	Total.	
No. 12 Party.— <i>High altitude Himālayas 10,000 to 23,000 feet.</i>	3-inch	Triangulation	77 D, 78 A ...	302'2	9'4	3'0	12'4	<u>EASTERN</u> <u>CIRCLE.</u> — <u>Concl.</u>
	1-inch	Original survey ...	79 N ...	22'4	19'2	11'0	30'2	Working on blue prints from 4-inch air surveys.
	... 1-inch	Compiled mapping	84 O, 84 C ...	.....	.....	2'5	.....
Fair mapping ...	...						

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of Work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Sq. m.	Sq. m.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
						Field work.	Mapping or computations.	Total.	
No. 6 (South India) Party.—									
Open undulating plateau at about 2,000 feet elevation, partly cultivated and partly stony grass land with occasional low flat topped and often scrub covered hills and ridges.	1-inch	47 L	...	4,561	877.1	0.91	0.28	1.19	<u>INDEPENDENT PARTIES.</u> "Triangulation" consisted of a reconnaissance to identify stations and points of the old triangulation of about 1880 and to supplement the old control where necessary.
	Triangulation								
Wooded Nilgiri peaks with grassy and cultivated downs.	2-inch	58 A	...	271	38.3	18.68	(a)	.....	(a) Mapping not yet done.
Open undulating plateau at about 2,000 feet elevation, partly cultivated and partly stony grass land with occasional low flat topped and often scrub covered hills and ridges.	1-inch	47 P	...	4,561	85.1	11.34	10.19	21.53	
	Supplementary survey.								

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING FUELS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or compu- tations.	Total.	
No. 6 (South India) Party. — <i>Conold.</i>								
.....	... 4-inch Compiled mapping	74 A, B ...	.....	.....	.....	3'62	.....	<u>INDE- PENDENT PARTIES. —</u> <u>Contd.</u> Total cost of office copy corrections and miscella- neous drawing Rs. 35,717. The above cost includes the cost of correction survey and verification of office copy corrections in the Stanley Reservoir area in sheets Nos. 47 and 68 which were commenced in September and completed in November 1938 and also the cost of revision frame- work of an area covering 950 square miles in sheet No. 48.
.....	... 4-inch Compiled mapping	65 J, M, N, 74 A, B.	.....	.....	.....	1'21	.....
.....	... ..... Colour patterns...	.....	.....	.....	.....	204'7 per sheet.	.....

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of Work.	Sheet Nos.	Area in sq. miles (or acres) of each description of work	Out-turn of field work per man per month.	Cost rate per Sq. M. (or Acre) of each description of work, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.
					Field work.	Mapping or computations.	Total.	
...	...	...	Sq. m.	Sq. m.	Rs.	Rs.	Rs.	<u>INDEPENDENT PARTIES.—</u> <u>Contd.</u>
Burma Survey Party.—								
Jungle covered hills up to 4,000 feet.	.....	91 B	884	2107	6'07	1'27	7'94	
Low jungle covered hills ...	.....	...	91 linear miles.	214 linear miles.	81'14	13'73	94'87	
Jungle plains ...	.....	85 N, O, 94 B, C.	51 linear miles.	328 linear miles.	43'16	13'73	56'89	
Cultivated plains ...	.....	...	94 linear miles.	402 linear miles.	31'80	13'73	45'59	
Cultivated plains ...	1½-inch	Original survey ...	73	317	21'10	11'79	33'19	For publication on 1-inch scale.
Low jungle covered hills ...	1½-inch	Original survey ...	72	100	61'06	11'79	73'75	

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.	
					Field work.	Mapping or computations.	Total.		
					Sq. m.	Sq. m.	Rs.	Rs.	<u>INDEPENDENT PARTIES.</u> <u>Contd.</u>
					Sq. m.	Sq. m.	Rs.	Rs.	
					Sq. m.	Sq. m.	Rs.	Rs.	
					Sq. m.	Sq. m.	Rs.	Rs.	
Burma Survey Party.—Contd..									
Cultivated plains	... 1-inch		1,514	31'1	21'68	11'79	33'47		
Low jungle covered hills	... 1-inch		175	18'8	68'70	11'79	80'49		
Jungle plains	... 1-inch		109	21'0	25'02	11'79	36'81		
Jungle plains	{ 8-inch 6-inch and 4-inch	85 N, O, 94 B	12	9'7	91'25	.....	.....	For Reserved Forest Maps.
Low jungle covered hills	... 1 1/2-inch		137	15'5	42'98	11'79	54'75	For publication on 1-inch scale.	
Low jungle covered hills	... 1-inch		480	18'1	42'59	11'79	54'38		

TABLE C.—Areas, out-turns and Cost rates of Surveys, Computations and Mapping.

Party	Class of work.	Sheet Nos.	Area in sq. miles (rounded) of each description of work.	Duration of field work per man per month.	COST RATE PER SQ. M. (ON BASIS) OF EACH DESCRIPTION OF WORK, EXCLUDING PAPERS AND MEN'S OTHER TRAINING.			REMARKS.
					Field work.	Mapping (including tab. M.).	Total.	
IND- PENDENT PARTIES.— <u>Contd.</u>								
* In areas of incomplete survey of 1903-31 Burma Revisited a period by late No. 11 Party, Survey of India.								
Cultivated plains	1-inch	Revision survey	20	200	3'10	11'73	17'10	
Low jungle covered hills	1-inch	Revision survey	125	947	7'04	11'73	19'05	
Mountainous Guide Map	4-inch	Revision survey	54	9'1	42'13	.....	.....
Jungle plains	4-inch	Original R. E. boundary P. T. Traverse.	17	.....	5'05	.....	.....	For the Burma Forest Department.

TABLE C.—Areas, out-turns and cost rates of Surveys, Computations and Mapping.

Party.	Class of work.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Out-turn of field work per man per month.	COST RATE PER SQ. M. (OR ACRE) OF EACH DESCRIPTION OF WORK, EXCLUDING PUPILS AND MEN UNDER TRAINING.			REMARKS.	
					Field work.	Mapping or compu- tations.	Total.		
Burma Survey Party.— <i>Concl'd.</i>					Sq. m.	Sq. m.	Rs.	Rs.	<u>INDE- PENDENT PARTIES.— Concl'd.</u>
<i>Fair mapping</i> ...	... 1-inch	Compiled mapping	84 D, 93 C, D	10,793	.....	.....	0'85	.....	Total cost of office copy, records and other miscella- neous work during the year was Rs. 29,407.
<i>Re-issues</i> ...	... 1-inch	.....	1 sheet	.....	.....	.....	350 per sheet.	.....
<i>Re-issues</i> ...	... 1-inch	.....	15 sheets	.....	.....	.....	339'13 per sheet.	.....
.....	... ..	Preparation of colour patterns.	19 sheets	.....	.....	.....	135'05 per sheet.	.....

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTOR:— Lt.-Colonel J. D. Campbell, R.E., to 18-2-39.
 Lt.-Colonel W. J. Norman, M.C., R.E., from 18-2-39 to 14-5-39.
 Lt.-Colonel E. O. Wheeler, M.C., R.E., from 14-5-39.

49. Summary.—The units administered by the Frontier Circle were 'A' and 'E' Companies, No. 18 Party, Lahore Survey Detachment and No. 6 Drawing Office.

The annual report of No. 6 Drawing Office is contained in Section XII of this volume, *vide* para. 142.

50. Training.—Ten soldier surveyors were under training in 'E' Company during the field season, of whom one was reverted to his regiment.

Military training is commented on in para. 55 below.

51. Special.—The Director, Frontier Circle, attended a conference of Directors held by the Surveyor General at New Delhi from 2nd to 6th January to discuss questions of policy consequent on the recognized necessity for more comprehensive methods of map maintenance and revision, *see* page 3. Lt.-Colonel W. J. Norman, M.C., R.E., also attended the conference.

Lt.-Colonel E. O. Wheeler, M.C., R.E., on behalf of the Director, Frontier Circle and Major D. B. Crompton, R.E., assisted in directing the combined military exercise held in 'A' Company in the autumn, *see* page 3.

52. Areas surveyed.—

1,726 square miles of triangulation.

15 square miles of triangulation to provide control for city surveys.

245 square miles of 1-inch survey (exploration).

102 square miles of 4-inch special survey.

205 square miles of 1:25,000 original survey.

119 square miles of 1:15-inch original survey.

651 square miles of 1-inch original survey.

166 square miles of 1-inch revision survey.

246 square miles of 1-inch provisional survey.

2,690 square miles of 1:2-inch original survey.

111 square miles of rectangulation from 2,000 acres to 25 acres.

111 linear miles of tertiary levelling.

7 square miles of 1-inch resurvey.

2,503 acres of large scale city survey on scale 100 feet to 1 inch.

1,212 acres of large scale city survey on scale 40 feet to 1 inch.

'A' Survey Company.

OF THE SURVEYOR GENERAL:— Major J. B. P. Anderson, R.E., R.E.

53. General.—The Company carried out topographical survey training of Class I officers in Kangra district and Bilaspur and Mandi States of the Punjab; rectangulation, levelling and special surveys for the Irrigation Department in Hissar district, Punjab; verification surveys in Jammu and Kashmir; revision survey of the Lahore Guide Map; city

surveys for the Municipal Committee of Murree, Punjab, and topographical surveys in the Karakoram.

Field headquarters were at Lahore Cantonment from 20th October 1938 to 6th April 1939 inclusive.

54. Personnel.—The average strength of the Company during the year was 1 Class I, 1 Class II, 3 U. S. officers and 32 Lower Subordinates.

In addition to the above, the following Class I officers were posted to the Company for training:—

Captain D. M. Clementi, R.E., until February.

Captain R. T. L. Rogers, R.E., until March.

Captain R. A. Gardiner, R.E., until June and again from mid-September.

Captain Gambhir Singh, I.A.

Captain R. S. Kalha, I.A.

Lieut. R. C. A. Edge, R.E., from December to March.

Mr. Tirlochan Singh (Class II) resigned in February. Rai Sahib C. L. Kapur (Class II) joined in August and Mr. Sheikh Alauddin (U. S. S.) joined at the end of January to supervise the work in Hissār district.

2 surveyors joined from No. 1 Party on 1st May for surveys in the Karakoram.

55. Military training.—During the first two months of the field season, with the exception of Mr. D. C. Puri and Mr. Tirlochan Singh (both Class II), all officers of the Company, reinforced by officers from No. 18 Party, carried out military training. The training comprised individual training in military duties, special technical training, practice formation of a military survey unit and collective training within the unit, co-operative training as a unit with the Survey Section R. A. and finally, a five day military survey exercise with R. A. units and essential services. Individual and Company training was in the Risālpur area and co-operative training with other arms in the area Akora-Attock-Hassan Abdāl-Nicholson Monument in sheets 43 C and G.

56. Areas surveyed.—

15 square miles of triangulation to provide control for city surveys.

238 square miles of $\frac{3}{4}$ -inch survey (exploration).

102 square miles of 4-inch special survey.

12 acres of large scale city survey on scale 40 feet to 1 inch.

111 square miles of rectangulation from 3,000 acres to 25 acres.

111 linear miles of tertiary levelling.

57. Field work was as follows:—

Normal topographical surveys on the 1-inch scale were arranged in Dera Ghūzi Khān, Dera Ismāil Khān and Muzaffargarh districts in sheets 39 I and M but were cancelled, owing to financial stringency, shortly before work was due to start.

Officers' training camp.—On conclusion of the military training period in December, Mr. Chiragh Shah proceeded to Hamirpur, Kāngra district and formed a camp for 5 Class I officers under training. Shortly after commencement of the camp, Mr. Chiragh Shah was nominated for

surveys in 'Irāq* and was relieved by Mr. Tirlochan Singh. On departure of Mr. Tirlochan Singh at the end of January, on leave pending resignation, the administration of the camp was undertaken in rotation by Captains Rogers, Clementi and Gardiner training being continued under direct orders of the O. C. Company.

Hissār Detachment.—In mid-December, at the urgent request of the Chief Engineer, P. W. D. Punjab, an estimate was framed for rectangulation, levelling and 4-inch survey, in the Sirsa tahsil of the Hissār district, as a basis for planning a canal system for the relief of this area, which is peculiarly subject to famine. It lies at the south west of the Bhakra Dam Project area. Provisional arrangements were made at once for the necessary personnel, equipment and instruments and within a fortnight of the work being sanctioned, the detachment commenced to assemble at Mandi Dabwālī under Mr. Sheikh Alauddin.

3 computers and 2 levellers were lent by the Geodetic Branch, 7 surveyors were provided by 'A' Company, 1 for levelling, 3 for 4-inch surveys, 2 for rectangulation and 1 to *partial* the work and act as general assistant. The remaining rectangulators and all inferior servants, except a small nucleus obtained from the Company, were specially recruited either from men with previous service or from local sources.

The detachment completed 111 square miles of rectangulation down to 25 acre blocks and replaced 167 missing stones in adjoining areas previously rectangulated. 111 linear miles of levelling and the 4-inch survey of 102 square miles covering parts of 11 irrigation map sheets, were also completed before the detachment dispersed on 14th April.

Karakoram.—Surveyors Fazal Elahi and Inayat Khan accompanied Mr. Eric Shipton on an expedition to the Karakoram. They left Murree on 8th June 1939 and are expected to return about middle of November. During this period they surveyed 238 square miles on $\frac{3}{8}$ -inch scale in the Biafo Glacier area in sheet 43 M. The few existing triangulated points were supplemented by Mr. Mott.

Verification Survey.—During the summer, surveyor Sohbat Shah carried out the verification of important information, in Jammu and Kashmir, in sheets 43 G, H, K, L and P.

This information had been received from extra departmental sources.

Murree City survey.—Operations to provide a framework for a survey, on a scale of 40 feet to 1 inch, of the bazaar and station wards of the Murree Municipal area, were carried out during the summer. The framework consisted of 9 stations of secondary triangulation connecting the area with the geodetic framework, 9 stations of local main triangulation and 20 stations of local subsidiary triangulation. 21 detail stations and 4.1 miles of detail traverse were also observed.

The work was started by Captain R. A. Gardiner, R.E., assisted by Captains Gambhir Singh, I.A., and R. S. Kalha, I.A., and Mr. U. D. Mamgain (U. S. S.). From June, Mr. Mamgain, assisted by one traverser borrowed from the Lahore Survey Detachment, carried on the work. In the latter half of the season, a test area was surveyed in detail and plotted, the area covering about 12 acres in one sheet.

58. Office work.—

Fair drawing.—During the field season a drawing section of average strength of 15 surveyors and draftsmen under Mr. D. C. Puri (Class II)

*Subsequently cancelled.

assisted by Messrs. I. K. Ponnappa and Chiragh Shah, (both U. S. S.) completed 5 sheets and worked on the drawing of 15 others.

During recess, this drawing section, with minor changes of personnel, completed 8 of these sheets, and in addition took up 6 quarter-inch sheets.

The total out-turn during the year was 13 sheets.

Map Maintenance.—In accordance with the map maintenance policy recently formulated by the Surveyor General (page 3), a section was formed in this unit for Map Maintenance. This section, consisting of 1 Class II officer, 1 clerk, 1 record keeper and 2 draftsmen, took over 49 office copies of primary sheets of Jammu and Kashmir and initiated arrangements for the systematic collection, verification and recording of new information in these areas.

Hissār Section.—Mr. Sheikh Alauddin, with 2 surveyors prepared the 11 field sheets of the Hissār work and the corresponding level charts and contour sheets. All sheets were submitted to the Director, Geodetic Branch for publication early in August.

Miscellaneous section.—A small section varying from 3 to 5 surveyors completed 75 traces of "base line" charts for the Director, Land Records, Punjab on repayment.

Computation section.—Computer Joti Sarup with 2 computers was fully employed throughout the year, first on military training and subsequently on preparation of record volumes, extraction of data, computations for the Murree survey and much miscellaneous work.

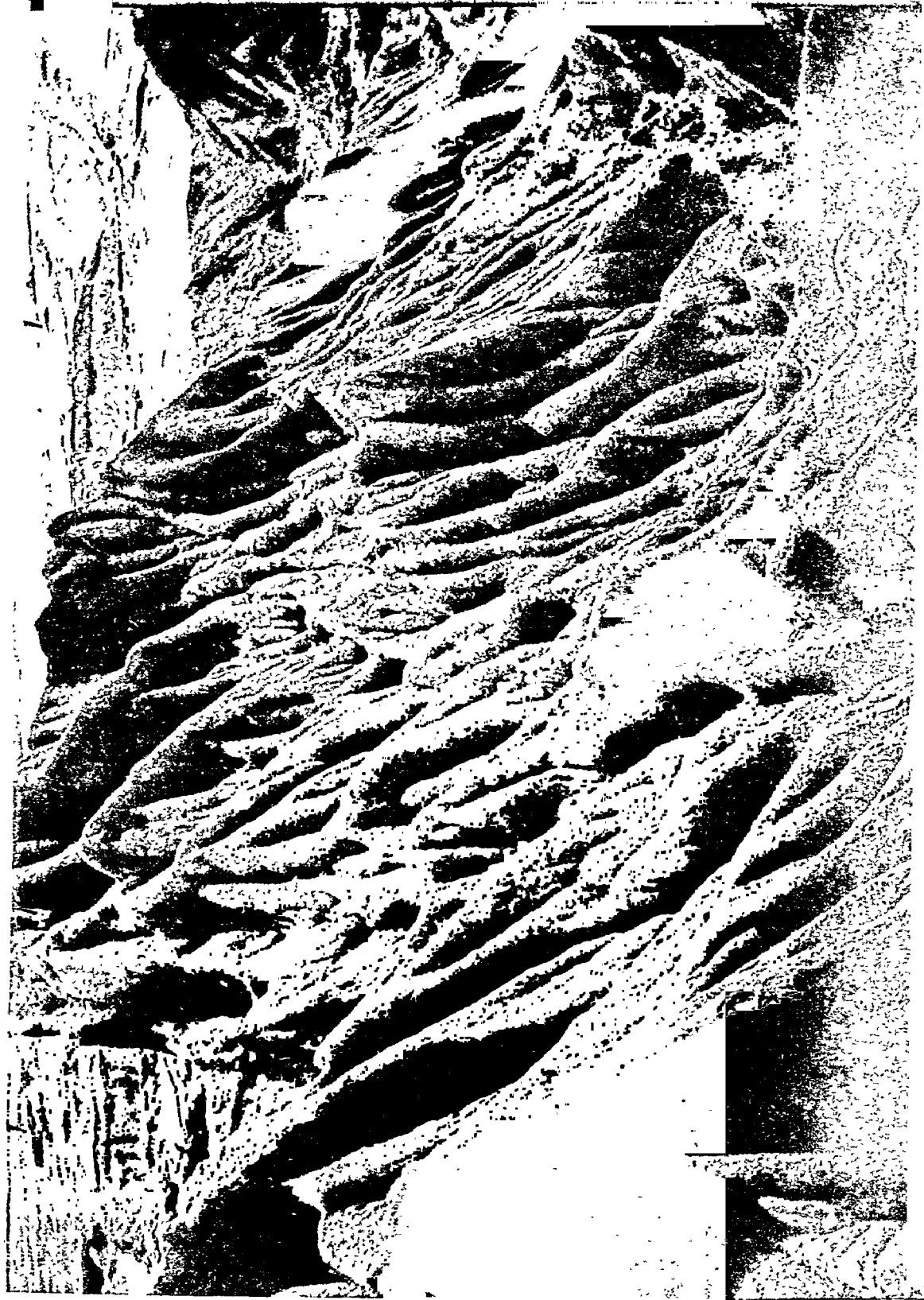
'E' Survey Company.

Officer Commanding.— $\left\{ \begin{array}{l} \text{Major D. R. Crone, R.E., to 13-2-39.} \\ \text{Captain D. E. O. Thackwell, R.E., from 1-2-39.} \end{array} \right.$

59. General.—The Company carried out surveys in Kalāt and Las Bela States of Baluchistān and Dādu district of Sind. Field headquarters opened at Karāchi on 22nd October 1938 and closed on 1st April 1939, on which date the permanent headquarters of the unit were transferred from Quetta to Karāchi. The buildings belonging to the Department in Quetta had been rendered unsafe by the earthquake of 1935, since when work had been carried on in tents and other temporary buildings. This was unsatisfactory, and pending a decision as to where new offices will be built, it was decided to move the headquarters to Karāchi. The old buildings were handed over to the Defence Department for demolition during June.

During December, Surveyors Muhammad Akram, Abdul Rahman I, and Muhammad Sadiq II were selected for service in 'Iraq and were withdrawn from the field. Their departure for 'Irāq was later cancelled and the surveyors were employed at headquarters.

60. Personnel.—The average strength during the year was 1 Class I officer, 3 Class II officers, 4 Upper Subordinate officers and 15 Lower Subordinates (excluding 3 clerks, 1 storekeeper clerk and 2 computers). In addition 10 soldier surveyors were attached for training during the field season, of whom 9 were retained for recess training. Captain D. E. O. Thackwell, R.E., joined the Company on 5th November 1938 and Captain R. A. Gardiner, R.E., proceeded to 'A' Company on 9th November 1938. Mr. Muhammad Najamuddin (Class II) rejoined from



leave on 8th October 1938 and was transferred to No. 6 Drawing Office from 12th September 1939. Mr. Chowdhury Muhammad Aslam (Class II) proceeded on 5 months' leave on 1st May. Mr. Vidya Dhar Chopra (U. S. S.) was temporarily transferred to Calcutta for a Map Sales tour on 8th October 1938 and rejoined the Company on 18th February 1939.

Messrs. Muhammad Akbar and Sardar Khan (both U. S. S.) joined the Company on 12th October 1938 and 28th October 1938 respectively.

61. Areas surveyed.—

- 1,726 square miles of triangulation.
- 7 square miles of 4-inch resurvey.
- 119 square miles of 1½-inch original survey.
- 547 square miles of 1-inch original survey.
- 2,690 square miles of ½-inch original survey.

62. Field work was organized as follows:—

Camp (1) under Mr. Mahammad Najamuddin (Class II) with 5 surveyors completed 1,468 square miles of ½-inch original survey in Kalāt and Las Bela States in sheet 35 K. One surveyor from this camp was recalled during December for service in 'Irāq.

Camp (2) under Mr. Chowdhury Muhammad Aslam (Class II) with 5 surveyors completed 1,222 square miles of ½-inch original survey in Las Bela State in sheet 35 K. One surveyor from this camp was recalled during December for service in 'Irāq. Another surveyor left the field on account of prolonged sickness and was replaced by a surveyor from headquarters.

The country surveyed by Camps (1) and (2) consists of a flat plain bordered on the east and west by high, broken and intricate hills. The hills to the west are notable for the presence of the well known mud hills and "mud volcanoes" of Baluchistān. These are known locally as *shur* hills, and consist of a honeycomb of sharp pinnacles and deep craters from which there are no apparent exits (See photograph). These hills are very dangerous to work on even in dry weather and after rain are quite impassable. There are no active volcanoes in the area surveyed but at Chandragup, which is near the coast and 8 miles to the west of the west edge of sheet 35 K, there is an active "mud volcano" which is a famous centre of pilgrimage of the local Hindu population. In this volcano there is a large tank of bubbling mud and water supported slightly above the level of the top of the volcano by a hard lip of mud crust. If this crust is broken away, mud will flow down the side of the hill until the crust reforms, which takes several hours. The water is said to have healing properties for various ailments.

The plain consists of shifting sand hills and sandy wastes near the sea coast with areas of bare *pat* and dense scrub inland. There is little cultivation as rainfall is normally scanty, and there is no irrigation system.

Camp (3) under Mr. N. D. Joshi (Class II) with 10 soldier surveyors (under training) completed 119 square miles of 1½-inch and 547 square miles of 1-inch original surveys in Dādu district in sheets 40 B and C.

The country surveyed was very barren consisting of large areas of flat stony waste interspersed with low hills and deep ravines. Water and habitation were scarce as was bird and animal life.

It was decided to include certain additional areas in the new edition of the Karāchi Guide Map which was being re-drawn in this Company. A surveyor was sent out for this purpose and completed 7 square miles of 4-inch resurvey.

Triangulation.—Mr. N. D. Joshi (Class II) and Mr. L. R. Howard (U. S. S.) completed 653 square miles of triangulation in Dādu district in sheets 40 B and C.

Mr. L. R. Howard (U. S. S.) completed 1,073 square miles of triangulation in sheet 35 O to provide ground control for the 1939-40 training camp. The work lay in Dādu district.

63. Office work.—Four surveyors under Mr. Muhammad Akbar (U. S. S.) were employed on fair mapping and miscellaneous work during the field season. During recess, fair mapping was divided into two sections. No. 1 under Mr. Mahammad Najamuddin (Class II) consisted on an average of 12 surveyors, and No. 2 under Mr. N. D. Joshi (Class II) consisted of 9 soldier surveyors under training. A third section was formed under the charge of Mr. Vidya Dhar Chopra (U. S. S.) to look after office copies and maintenance, the computation section and miscellaneous work.

64. Reproduction Section.—The reproduction section attached to this unit was finally closed down in October and the personnel transferred to other units.

No. 18 (Air Survey) Party.

Officer in charge.— { Captain R. C. N. Jenney, R.E., to 23-2-39.
 { Major D. R. Crone, R.E., from 24-2-39.

65. General.—Recess and field headquarters remained at Murree and Risālpur respectively, the latter opening on 20th October 1938 and closing on 17th April 1939.

66. Personnel.—The average strength of the party was 2 Class I, 3 Class II, 4 Upper Subordinate officers and 24 Lower Subordinates (excluding clerks and reproduction section personnel).

67. Areas surveyed.—

- 205 square miles compiled (1/25,000 original survey).
- 104 square miles compiled (1-inch original survey).
- 166 square miles compiled (1-inch revision survey).
- 240 square miles compiled (1-inch provisional survey).

68. Field work.—

- 1,491 square miles of vertical photography.
- 201 linear miles of oblique photography.

No. 1 (Indian) Wing Station, R. A. F., Kohāt supplied vertical photographs of 1,286 square miles in tribal territory in sheets 38 L and O and oblique photographs of 11 linear flying miles in tribal territory for height determination.

No. 2 (Indian) Wing Station, R. A. F., Risālpur supplied oblique photographs of 190 linear flying miles in tribal territory. Vertical air photographs of 205 square miles in sheets 53 H and 47 F were supplied by the C. G. S.

Captains R. T. L. Rogers, R.E., and R. A. Gardiner, R.E., and Lieut. R. C. A. Edge, R.E., calibrated 17 F/8 cameras and 3 F/24 cameras during the year.

69. Stereocomparator control.—Major D. R. Crone, R.E., observed 10 pairs; Mr. K. L. Dhawan (Class II) 7 pairs; Mr. E. R. Wilson (Class II) 3 pairs; and Mr. O. P. Anand (U. S. S.) 8 pairs of oblique air photographs in the Stereocomparator for experimental work and for control of air survey in tribal territory. The area controlled was 110 square miles.

70. Compilation.—Compilation was carried out in sheet 38 O under Mr. K. L. Dhawan (Class II) and in sheet 38 L under Mr. E. R. Wilson (Class II).

Compilation in sheets 53 H and 47 F was carried out in the course of training under Khan Sahib Muhammad Hasan (Class II).

71. Office work.—Five draftsmen under Mr. Bashirullah Khan (U. S. S.) were employed on fair mapping and miscellaneous work throughout the year. Three fair sheets and three masks were completed and submitted for publication during the year.

72. Training.—During the year 2 Class I, 2 Upper Subordinate officers and an average of 7 Lower Subordinates were under training in air survey. 2 Class I and 2 Class II officers were also trained in the use of the Wild photo-theodolite.

73. Instruments.—A parallax measuring bar was designed for use with the M. I. O. pattern stereoscope.

74. Co-operation with the Army and R. A. F.—A Hunter short base extension carried out for training was used to fix rangefinder points near Risālpur.

During recess Northern Command intelligence courses for officers and British other ranks visited the office and air survey methods were demonstrated.

75. Reproduction Section.—For detail of the work of the reproduction section, see page 77.

Lahore Survey Detachment.

Officer in charge.—Mr. F. D. Gibb.

76. General.—This detachment was formed for the large scale survey of the urban and suburban areas of Lahore, for the Punjab Government which pays its entire cost.

The programme, which is expected to take over two years to complete, consists of about 6,000 and 15,000 acres for survey on the scales of 40 feet and 100 feet to an inch respectively, and of the provision of traverse control for square laying, over about 3,000 acres; the latter is made up of separate areas adjacent to the area for detail survey.

Field operations opened at Lahore in September 1938.

77. Personnel and distribution of duties.—The strength, excluding the officer in charge, was 5 Upper Subordinate officers and 36 Lower Subordinates, including 3 clerks.

Messrs. K. B. Muthanna, B. B. Kuttappa, U. D. Mangain, (all U. S. S.) till his transfer in June, and Mr. G. S. Sidhu (U. S. S.) from June, and 14 Lower Subordinates were employed on field duties.

A drawing section under Mr. G. S. Sidhu (U. S. S.) till June, and later under Mr. Manawar Khan (U. S. S.) with 14 Lower Subordinates and a computing section under Mr. Saiyid Irshad Ahmad (U. S. S.) with 8 Lower Subordinates dealt with the fair plotting and computations respectively.

78. Field work.—Commenced in September 1938.

Control.—The main triangulation consisting of 69 stations, mainly 'up' or roof-top stations, and covering an area of 19,200 acres was carried out under the supervision of Captain D. M. Clementi, R.E., who was temporarily attached to the unit.

The main triangulation was broken down by subsidiary triangulation in order to provide a sufficient number of 'downs' or stations at ground level. The down stations were linked up by 470 linear miles of traversing.

Detail survey.—1,200 acres on the 40-foot and 2,804 acres on the 100-foot scales were completed during the year under report.

In congested areas, especially in narrow, busy streets and lanes difficulties have been caused by pedestrians, cars tongas etc. getting in the way and thereby obstructing observation and ground measurements.

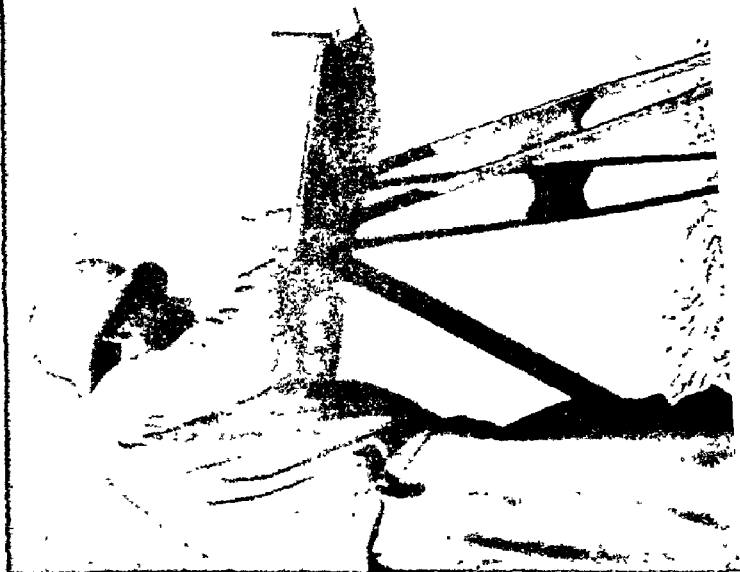
Fair plotting of detail.—The plotting of detail on the fair plots, from which the final maps will be printed, was carried on *pari passu* with the detail survey.

Close touch was maintained with the Settlement Department under Mr. G. B. Abell, I.C.S.

Offsetting machine.—Offsetting to detail has hitherto been carried out principally by means of the "Optical square", offsets being limited to 10-15 feet, limitations which that rather imperfect instrument imposes. With the introduction of the special "Offset Machine", constructed in the Mathematical Instrument Office, the range to which accurate offsets can be taken has increased very considerably. The machine enables offsets being taken with sufficient accuracy on the 40 feet to an inch scale to a range of 150 feet though this rather arbitrary range limit has been fixed only provisionally. With more experience of the machine and experimental work it may be possible to increase the range. The density of traverse control is determined by the range to which offsets to detail may be taken with accuracy; it can be seen therefore that the wider the range (of accurate offsetting) the cheaper the survey.

Gauss scales devised by Brigadier Lewis and constructed in the Mathematical Instrument Office are in use for plotting. These scales are easy and rapid to use.





PLANE-TABLE
SURVEYOR
AT WORK IN THE
HIMALAYAS—
NANDA DEVI AND
NANDA KOT
IN THE
BACKGROUND.

VI.—SURVEY REPORTS, GEODETIC BRANCH.

No. 1 Party.

Officer in charge.—{ Major G. H. Osmaston, M.C., R.E., to 14-6-39.
Mr. W. H. Strong, M.N.E., from 15-6-39.

79. General.—The party carried out topographical surveys in Central India, Gwalior, Rājputāna and the United Provinces in sheets 46 I, 46 M and 62 B.

The programme also included the following special surveys, on payment:—

(a) A military training map, on the 1-inch scale in Bhopāl State, at the request of the Darbār in sheet 55 E.

(b) Demarcation of a boundary dispute between Adhoi (Morvi) and Shivilakha (Cutch) in sheet 41 I.

Contributions were received during the year towards the cost of the topographical surveys in their territories from the States of Jodhpur (Mārwar), Gwalior, Indore, Bānswāra, Jaora, Ratlām and Partābgarh.

The party headquarters moved in November from Mussoorie to Dehra Dūn and remained there for the rest of the year.

80. Personnel.—The strength of the party during the field season was 1 Class I, 4 Class II, 4 Upper Subordinate officers, 57 Lower Subordinates, including 7 pupil surveyors and 4 clerks.

81. Areas surveyed.—

- 273 square miles of 1-inch original survey.
- 72 square miles of 1-inch resurvey.
- 90 square miles of 3-inch verification survey.
- 347 square miles of 2-inch verification survey.
- 1,153 square miles of $\frac{3}{4}$ -inch original survey.
- 27 square miles of $\frac{3}{4}$ -inch revision survey.
- 267 square miles of $\frac{3}{4}$ -inch verification survey.
- 6,277 square miles of $\frac{1}{2}$ -inch original survey.
- 820 square miles of supplementary triangulation.
- 71 linear miles of supplementary traverse.

82. Field work.—

Almora Detachment.—*Camp (1)* under Mr. J. C. Ross (Class II) with one U. S. S. officer and 6 surveyors completed 666 square miles of $\frac{3}{4}$ -inch original survey in sheets 62 B/NW and SW and 204 square miles of 2-inch verification survey (vegetation only) in sheet 62 B also 267 square miles of $\frac{3}{4}$ -inch verification survey (vegetation only) in sheet 53 N.

Camp (2) under Mr. J. N. Kohli (U. S. S.) with one U. S. S. officer and 6 surveyors completed 487 square miles of $\frac{3}{4}$ -inch original survey and 27 square miles of $\frac{3}{4}$ -inch revision survey in sheets 62 B/NW, SW and SE and 143 square miles of 2-inch verification survey (vegetation only) in sheet 62 B.

The area surveyed by these two camps comprised the upper basins of the Goriganga and Dārmaganga Rivers from the main Himālaya range northwards as far as the Tibetan border. The camps concentrated at Almora about 24th August and reached camp headquarters at Milam and Bāling about the 10th September. Transport as far as camp head-

quarters was partly by mules but mostly by Dotiāl and Dhānpuri coolies enlisted at Almora, and a few specially selected Niti and Māna coolies. The journey to the field was made during the end of the monsoon and for this reason several rivers were difficult to cross and conditions generally uncomfortable. By the 15th September weather cleared up sufficiently for plane-tableing which continued till 15th November when the winter snowfalls commenced just as the work was completed.

The area included the Milam Glacier, the eastern flanks of the Nanda Devi basin, Nanda Kot and Pānch Chūlhi peaks. A number of glaciers measured by the Geological Survey between 1906 and 1911 were remeasured and most of them were found to have retreated—the Milam Glacier as much as 560 yards in 33 years.

Many of the glaciers in this region are steep and broken and it was found exceptionally difficult not only to reach some of their upper basins but even to see them from a distance. The whole area was evacuated by the local inhabitants by the middle of October.

Local coolies were largely employed for the high work and some of them proved to be good mountaineers. Specially selected experienced men from Māna and Niti were also used again and worked exceptionally well.

To complete Almora district the valley of the Kuthi Yānkti River still remains to be surveyed; it is hoped that it will be possible to take up work in the autumn of 1940.

Central India Detachment under Mr. T. M. C. Alexander (Class II) with headquarters at Ratlām, worked in the States of Central India and Rājputāna.

Camp (3) under Mr. K. A. Sheikh (Class II) with 10 surveyors completed 3,269 square miles of $\frac{1}{2}$ -inch original survey in sheets 46 I and M, in the States of Indore, Bānswāra, Piploda, Ratlām, Sailāna, Dewās (senior), Dewās (junior), Jaora, Sitāmau, Jhālāwār, Partābgarh and Udaipur (Mewār), and the Mandasor, Shājāpur and Ujjain districts of Gwalior and Panth Piploda Chief Commissionership.

Camp (4) under Mr. M. W. Kalappa (U. S. S.) till December and then under Mr. T. M. C. Alexander, with 9 surveyors completed 3,008 square miles of $\frac{1}{2}$ -inch original survey in sheets 46 I and M, in the States of Indore, Dewās (senior), Dewās (junior), Dhār, Ratlām, Sailāna, Jhābua, Kushālgarh, Bānswāra, and the Ujjain district of Gwalior.

A Training Camp under the Detachment Officer with Surveyor Najmul Husain as Instructor, with 9 pupils and others under training as surveyors, completed 273 square miles of 1-inch original survey in sheet 46 M/3, in the States of Ratlām, Sailāna and Dhār and the Ujjain district of Gwalior.

Cutch-Morvi boundary demarcation.—In addition to his other duties Mr. Alexander carried out the demarcation of 4 miles of boundary which had been the subject of a long standing dispute between Adhoi (Morvi) and Shivrakha (Cutch) villages in sheet 41 I during January.

The country surveyed in Central India comprises a rolling plateau sloping gently downwards to the north-east, and descending more steeply in a series of scarps and ravines to the south-west. The area includes the main watershed between the Chambal to the north and the Mahi River flowing south-westwards. The Chambal basin is extensively culti-

vated though the soil is not deep and there are considerable areas of rock outcrop and stony waste. Shallow wells and tanks with *bunds* are numerous. The area draining into the Mahi River consists of sparsely wooded deeply ravined hills, and is only cultivated in patches near the ever shifting Bhil hutments. The streams dry up for several months every year and water becomes scarce. The climate is hot and malarious until the end of November; the heat in April is severe and diseases such as small pox and dysentery become prevalent at this time.

Determination of Geographical positions of Wireless telegraph stations.—At the request of the Divisional Wireless Engineer, Bombay, a surveyor was deputed to fix by plane-table resections the positions of the receiving and transmitting wireless stations located near Lashkar (Gwalior).

Bhopal Survey.—Surveyor Muht. Rashiduddin completed 72 square miles of re-survey S. E. of Bhopal city in sheet 55 E. This survey was required by the State for a special military map to supplement a similar training map made last year.

Delhi Guide Map.—Surveyor Muht. Rashiduddin completed 90 square miles of 3-inch verification survey of the Delhi Guide Map in sheet 53 H. This was required for the reissue of the Guide Map by No. 2 Drawing Office.

Frame Work.—Mr. Muht. Z. A. Qureshi (U. S. S.) carried out 820 square miles of supplementary triangulation and 71 linear miles of supplementary traverse in sheet 46 E.

Drawing Section.—During the winter a small drawing section remained at party headquarters at Dehra Dūn employed chiefly on the mapping of Himālayan sheets, Drawing Office corrections to the C. I. and Sind sheets, and a special map of Mārwar.

83. Recess duties.—The party was organized for recess into 3 main sections.

No. 1 Section under Mr. J. C. Ross (Class II), assisted by Mr. J. N. Kohli (U. S. S.), mapped the Himālayan areas and also completed the map of Mārwar.

No. 2 Section under Mr. T. M. C. Alexander (Class II), mapped the areas surveyed by camp (4).

No. 3 Section under Mr. K. A. Sheikh (Class II), mapped the areas surveyed by camp (3).

The drawing of the training map of Bhopal was handed over to No. 2 Drawing Office.

No. 20 (Cantonments) Detachment.

Strength Report.—{ Mr. W. H. Street, M.B.E., U.I.C.S.
Mr. M. Arshad, from 15.6.39 }

84. General.—The detachment surveyed cantonments and their bāzars on the 16-inch and 64-inch scales respectively, in accordance with the programme approved by the Engineer-in-Chief and the Defence Department.

The field season commenced on the 17th October 1938 and closed on the 20th May 1939, field headquarters remaining at Dehra Dūn.

Personnel.—The field strength, excluding the officer in charge, was 2 U. S. officers and 31 Lower Subordinates, including 4 draftsmen, 4 computers and 3 clerks employed at field headquarters.

For varying periods, 1 traverser, 1 computer and 2 surveyors were attached to the detachment for work paid for out of extra-departmental funds.

85. Areas surveyed.—

16-inch original survey.

Drigh Road Cantonment	7,856.0 acres.
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64-inch original survey.

Drigh Road Cantonment Bāzār	16.0 acres.
Kohāt Cantonment Bāzār	7.8 "

16-inch resurvey.

Kohāt Cantonment	3,179.0 acres.
Siālkot	"	...	7,608.8 "

64-inch resurvey.

Siālkot Cantonment Bāzārs	170.2 acres.
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The above areas include overlap.

Boundary and miscellaneous survey.

Bakloh (Rifle Range) boundary survey.

Bakloh Range points (12 points were fixed).

Ambāri Tea Estate, Dehra Dūn, boundary survey.

86. Field work was organized as follows:—

Camp (1) with headquarters at Drigh Road under Mr. Bakhshi Harnam Singh (U. S. S.) with 8 surveyors and 2 traversers completed the detail survey of Drigh Road and Kohāt Cantonments, and the advance traversing and levelling of Bannu, Cherāt, Dera Ismāil Khān and Fort Akālgarh and Jhelum Cantonments.

The traversing of the estate boundary of the Ambāri Tea Estate, Dehra Dūn, and an extension to the Kohāt Cantonment were also completed.

The position of the Wireless mast in the compound of the office of the Director General of Observatories, Poona, was fixed.

One tindal was attached to the camp for training in plane-tableing.

Camp (2) with headquarters at Siālkot under Mr. A. Francis, (U.S.S.) with 8 surveyors and 2 traversers completed the detail survey of Siālkot Cantonment, and the advance traversing of Dalhousie and Jullundur Cantonments.

This camp also completed the traversing of parts of the Allahābād and Cawnpore Cantonment boundaries, the Bakloh Cantonment (Rifle Range) and fixed range-finding points in Bakloh Cantonment.

87. Traversing and Levelling.—3.4 linear miles of traversing were completed for the current season's survey in Kohāt Cantonment, and 295.3 linear miles of traversing and 101.0 linear miles of levelling were completed for next season's survey in Bannu, Cherāt, Dalhousie, Dera Ismāil Khān and Fort Akālgarh, Jhelum and Jullundur Cantonments.

The following traversing was also carried out:—

- (a) 2.0 linear miles, for the boundary survey of the Bakloh Cantonment (Rifle Range).
- (b) 0.4 linear miles, for fixing 12 range-finding points in Bakloh Cantonment.
- (c) 3.9 linear miles in connection with the boundary alterations at Allahābād and Cawnpore.
- (d) 20.1 linear miles, for the extra-departmental boundary survey of Ambāri Tea Estate, Dehra Dūn.
- (e) 5.4 linear miles, for fixing the position of the Wireless mast in the compound of the Director General of Observatories, Poona.

88. Recess duties.—Fair mapping was carried out by two sections during the recess under Messrs. Bakhshi Harnam Singh (U. S. S.) and A. Francis (U. S. S.), the former also supervised the computation section.

A section of 4 draftsmen and 4 computers under the supervision of the officer in charge, was employed throughout the field season to deal with arrears of mapping and computation of the advance frame work.

21 sheets on the 16-inch scale and 21 sheets on the 64-inch scale of *Cawnpore, Drigh Road, Kohāt, *Mardān, *Peshāwar and *Risālpur Cantonments and Bāzārs were completed and sent for publication, while 26 sheets on the 16-inch scale and 5 sheets on the 64-inch scale of Drigh Road, Kohāt and Siālkot comprising the current season's mapping were partially completed.

The computation of traversing and levelling carried out during the field season was also completed during recess.

* Arrears mapping.

VII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:— { Colonel F. B. Scott, I.A., to 5-3-39.
 { Lieut.-Colonel T. M. M. Penney, from 6-3-39.

89. **Summary.**—The units administered by the Eastern Circle were Nos. 4, 5 and 12 Parties, and No. 5 Drawing Office.

Owing to financial restrictions the field programme of all parties was much curtailed.

90. Areas surveyed.—

250 square miles of $\frac{3}{4}$ -inch original survey.
3,646 square miles of 1-inch original survey.
4,701 square miles of triangulation.

91. Survey operations in Sikkim State.—

Work in connection with survey operations in Sikkim State is described in No. 12 Party's report (p. 54).

92. **Training.**—A training camp was formed at Barāpāni near Shillong for the following officers:—

Probationer, Class I Service	...	...	One.
Probationers, Class II Service	...	...	Two.
U. S. Officers (recently confirmed)	...	...	Two.

Two pupil surveyors were under instruction in No. 5 Drawing Office.

93. **Special.**—An office copy section has been started in No. 12 Party for maintenance of primary sheets.

No. 4 Party.

Officer in charge.—Mr. A. J. A. Drake, D.C.M.

94. **General.**—Owing to financial stringency only a portion of the party took the field and continued surveys on the 1-inch scale in Champāran, Darbhanga and Muzaffarpur districts of Bihār in sheet 72 F.

No advance framework was undertaken, as it was anticipated that there would be no field operations in 1939-40.

Mr. U. D. Mangain (U. S. S.) in charge of the traverse computation was transferred in November and Mr. P. K. Chowdhury (U. S. S.) relieved him. The traversers were transferred to the Lahore Survey Detachment and on completion of computations the computers were transferred to the compilation section of No. 5 Drawing Office.

Mr. J. C. Berry (Class II) with 4 surveyors completed the final examination of the remaining 1-inch sheets, after the field personnel had left. In December, on the conclusion of this work the surveyors were transferred to other units, while Mr. J. C. Berry did miscellaneous work for No. 5 Drawing Office.

Two (Class II) probationers and two (U. S. S.) officers received additional training in 1-inch hill surveys, in the vicinity of the Shillong-road, for a period of about 5 months, under the supervision of L. H. Sams, R.E., officer in charge, No. 12 Party.

Field headquarters remained at Shillong. Camp headquarters which opened at Laheria Sarai on the 13th November, were moved to Muzaffarpur early in February and closed there on the 26th April.

95. Personnel.—The field strength consisted of 2 Class II officers and 16 surveyors.

96. Areas surveyed.—

2,076 square miles of 1-inch original survey.

97. Field work was organised as follows:—

Mr. N. N. Chuckerbutty (Class II) with Mr. M. Alauddin (Class II) as Assistant Camp officer and 16 surveyors completed 2,076 square miles of original survey on the 1-inch scale in sheet 72 F in the Champāran, Darbhanga and Muzaffarpur districts of Bihār.

The Director accompanied by the officer in charge inspected the field work in January and the officer in charge did a second inspection in March.

98. Description of country.—The area under survey is a flat alluvial plain, intersected by rivers and innumerable natural drainage channels; it is well populated, highly cultivated, and has numerous gardens and scattered trees. Although there were serious floods in North Bihār during the monsoon of 1938, there was little or no evidence of this when the party took the field in November and the surveyors were able to commence work without delay.

Railway communications are good and there are many motorable roads throughout the area.

99. Miscellaneous.—The prevailing diseases in the districts are malaria and hookworm. The health of the camp was very good, the only serious illness being that of an inferior servant who was certified as unfit for further service of any kind.

100. Recess duties.—The nine 1-inch sheets surveyed during the field season were fair mapped during recess by two sections under Messrs. N. N. Chuckerbutty and J. C. Berry (both Class II).

No. 5 Party.

<i>Officer in charge.</i>	{	Captain I. H. R. Wilson, R.E., to 15-11-38
		Mr. F. W. Smith, from 16-11-38 to 8-12-38.
		„ C. H. Tresham, V.D., from 9-12-38 to 23-12-38.
		„ F. W. Smith, from 24-12-38.

101. General.—Due to financial restrictions the programme was curtailed to only 5 sheets on the 1-inch scale in the Raipur district of the Central Provinces and Berār, the Sambalpur district of Orissa, and in the Chhattisgarh States (Eastern States Agency) in sheet 64 L. Contouring at 5 foot intervals was carried out in those areas of the 16-inch Air Survey Map of Jamshedpur, not contoured in season 1936-37.

Triangulation for topographical survey was carried out in the Chānda district of the Central Provinces and Berār and the Bastar State of the Eastern States Agency, in sheet 65 A.

The Party headquarters remained at Shillong. About 80 regular inferior servants had to be discharged owing to the curtailment of programme.

102. Personnel.—The field strength consisted of 3 Class II officers, 1 U. S. S. officer, 13 surveyors and 1 computer.

103. Areas surveyed.—

1,394 square miles of 1-inch original survey.

10 square miles of contouring at 5 foot intervals.

2,243 square miles of triangulation for $\frac{1}{2}$ -inch survey.

104. Field work was organised as follows:—

Camp (1).—The headquarters were at Raipur until 14th January 1939 and afterwards at Kantābānji. Mr. H. H. Phillips (Class II) in charge assisted by Mr. A. R. Khan (U.S.S.) and 9 surveyors completed 1,394 square miles of original survey on the 1-inch scale in sheet 64 L in Raipur district (C. P. and Berār), Sambalpur district (Orissa), and Kālāhandi and Patna States (Eastern States). One surveyor was declared medically unfit to take the field on arrival at Raipur and was sent on leave; the camp was reinforced by 2 surveyors, one arriving on 20th December 1938 and the other on 2nd January 1939. On completion of the work at Jamshedpur, the camp was further reinforced by 2 surveyors and one computer on 1st February. One surveyor was recalled to Shillong on 11th February, and another surveyor was transferred to No. 18 Party on 24th March.

Camp (2).—Headquarters, Jamshedpur. Surveyor Govind Prasad was in charge and with one surveyor and one computer doing levelling completed the contouring at 5 foot intervals of 10 square miles in 6 complete sheets and parts of 5 others, of the 16-inch Air Survey Map of Jamshedpur.

Triangulation.—Messrs. L. J. Bagnall and N. L. Gupta (both Class II) completed the triangulation of 2,243 square miles in sheet 65 A in Chānda district (C. P. and Berār) and Bastar State (Eastern States).

105. Description of country.—The country consisted of open and wooded cultivated plains and thickly jungle covered plains and low hills with rocky outcrops.

106. Miscellaneous.—Health in the field was very fair considering that the area was very malarious. Mr. Bagnall had a severe attack of malaria in December and was under medical treatment for 15 days, while later in March and April he had further attacks which greatly retarded his progress. One surveyor also had a very severe attack of malaria. One khalasi died of pneumonia in Khariār hospital.

107. Recess duties.—The five 1-inch sheets surveyed during the field season were fair mapped under the supervision of Mr. B. N. Saha (Class II) assisted by Mr. L. J. Bagnall (Class II). The compilation of reductions of the 16-inch Air Survey Map of Jamshedpur on 8-inch, 4-inch and 2-inch scales; and the correction of $\frac{1}{2}$ -inch sheet No. 55 C were carried out under the supervision of Mr. B. N. Saha assisted by Mr. N. L. Gupta.

Fair copies of the contouring of the 11 sheets of the 16-inch Air Survey Map of Jamshedpur were prepared under the supervision of

Mr. B. N. Saha and supplied to the Tata Iron and Steel Coy. Ltd., Jamshedpur.

Messrs. L. J. Bagnall and N. L. Gupta computed their own triangulation.

No. 12 Party.

Officer in charge.—Captain R. H. Sams, R.E.

108. General.—The survey operations of the party in sheets 77 D, 78 A and 79 N included the survey on the $\frac{3}{4}$ -inch scale of part of Sikkim State and the completion of the survey of Chittagong district and Chittagong Hill Tracts of Bengal on the 1-inch and $\frac{1}{2}$ -inch scales.

Triangulation for topographical survey on the $\frac{3}{4}$ -inch scale was carried out in Sikkim State from September to December 1938, and from March to May 1939, in sheets 77 D and 78 A.

Verification surveys on the 1-inch scale in connection with the reissue of sheets were carried out in sheet 78 P.

A maintenance section was organised and developed in furtherance of the recently introduced maintenance policy.

The majority of the party did not take the field, and the headquarters remained in Shillong.

109. Personnel.—The strength of the party was 1 Class I, 2 Class II, 5 Upper Subordinate officers on an average, and 23 Lower Subordinates.

110. Areas surveyed.—

176 square miles of 1-inch original survey.

250 square miles of $\frac{3}{4}$ -inch original survey.

64 items of detail of verification survey.

2,458 square miles of triangulation for $\frac{3}{4}$ -inch survey.

111. Field work was organised as follows:—

Survey camp.—Two surveyors completed 176 square miles of original survey on the 1-inch scale. This area comprised the remainder of sheet 79 N/9, which was partially surveyed last field season.

The country consisted of low densely forest-clad hills with an intricate system of *nālas* and small areas of cultivated plains. *Machān* fixings had to be used extensively for work in the forest areas.

Communications throughout were only fit for coolie transport which was easily obtainable.

Health.—The health in this camp remained good throughout the work. One local man employed as a khalasi fell from a *machān*. His injuries, though not serious, necessitated his removal to hospital.

Sikkim triangulation.—Lieut. L. H. Williams, R.E., (Class I) and Mr. A. Ahad (Class II) left Gangtok on 7th September 1938 to start the triangulation. On 12th September, while camping at over 12,000 feet, Lieut. L. H. Williams was struck by lightning and had to be evacuated from the area. His place was taken by Captain R. H. Sams, R.E.

Mr. Ahad completed 940 square miles of triangulation in sheet 78 A from September to December 1938.

Captain R. H. Sams, R.E., carried out the reconnaissance of 750 square miles in sheets 77 D and 78 A, but was unable to take any observations due to the bad weather, poor visibility and delays caused by disaffection among the transport coolies.

The area remaining incomplete in sheets 77 D and 78 A was triangulated by Mr. A. Ahad from February to May 1939.

Garhwali khalasis, having experience of high Himālayan survey work, were transferred temporarily from No. 1 Party for the work.

112. Description of country.—The country consists of high precipitous mountains which average in height from 10,000 feet in the south to 20,000 feet in the north, and includes some of the highest and best known peaks of the Himālayas, such as Kānchenjunga 28,168, Pauhunri 23,385, Jongsong Peak 24,472, The Twins 24,114, Kabru 24,078, and Siniolchu 22,595.

The valleys are mostly covered with dense jungle, which varies from tropical forest growth in the lower valleys to fir and rhododendron up to 12,000 feet. The lower valleys are infested with leeches.

The altitude of the snow line in the autumn varies from 17,000 to 18,000 feet, but in the winter snow lies at 9,000 feet.

The Tista River, rising from Pauhunri in the north, drains the whole of Sikkim.

Weather.—The weather experienced during the triangulation in the autumn was extremely bad. The monsoon continued beyond the normal time and the winter snow storms arrived early. It was only well after the middle of November that reasonably clear weather was experienced, but by then the cold and depth of soft snow in the higher regions prevented further work in north Sikkim, though triangulation was continued under extreme difficulty in the southern area until the 17th December.

In the spring, when the triangulation was continued the weather improved slightly during March, but some very heavy falls of snow were experienced: it however further improved up to May when the work was completed.

Sikkim survey.—Mr. A. Ahad (Class II) with Mr. J. N. Kohli (U. S. S.) and 6 surveyors completed 250 square miles of original survey on the $\frac{3}{4}$ -inch scale in sheets 77 D and 78 A.

This camp reached Gangtok on 1st August and proceeded direct to the north of Sikkim, where the survey was started out of reach of the main monsoon weather. The camp is still in the field and is not expected to complete its work till April 1940.

Training camp.—During October a training camp was formed at Barāpāni under Mr. J. McCracken (Class I), in charge of No. 5 Drawing Office, for the training in hill plane-tableing on the 1-inch scale, of the following officers:—Lieut. Gurdip Singh, I.A. (Class I) of No. 5 Party, Messrs. Suresh Prasad, R. L. Ghei (both Class II), Jagan Nath and R. R. Sahai (both U. S. S.) of No. 4 Party.

Captain R. H. Sams, R.E., took over charge of the camp on 14th November. The camp was closed on 11th March.

113. Recess duties.—The party was organised in two drawing sections under Messrs. H. H. Phillips (Class II) and J. R. Chibbar

(U. S. S.). Messrs. A. Ahad (Class II) and S. B. P. Mathur (U. S. S.) also held charge of drawing sections for part of recess.

Mr. Hari Singh (U. S. S.) had charge of the newly formed maintenance section.

The one 1-inch sheet, the survey of which was completed during the season, was fair mapped, and the computations for the Sikkim triangulation were completed.

In addition three $\frac{1}{2}$ -inch sheets were fair drawn, while the process of getting $\frac{1}{4}$ -inch sheets on to separate originals was completed for six sheets.

VIII.—SURVEY REPORTS, INDEPENDENT PARTIES.

114. No. 6 (South India) and Burma Survey Independent Parties are administered directly by the Surveyor General. Their mapping and survey areas are approximately the same as those of the former Southern and Burma Circles respectively, abolished in 1932.

No. 6 (South India) Party.

Officer in charge.— $\left\{ \begin{array}{l} \text{Major G. W. Gemmell, I.A., to 6-6-39.} \\ \text{Mr. N. S. Harihara Iyer, from 7-6-39 to 30-7-39 and from 19-8-39 to 29-9-39.} \\ \text{Mr. E. N. Natesan, from 31-7-39 to 18-8-39.} \\ \text{Captain I. H. R. Wilson, R.E., from 30-9-39.} \end{array} \right.$

115. General.—The Party completed its programme of 1-inch topographical surveys in Bombay, Kolhāpur State and the Deccan States and triangulation in the same Province and States for the control of next season's 1-inch survey. Field work commenced at the beginning of November 1938, and personnel engaged on it had returned to recess in Bangalore by the middle of April 1939. In addition to the above, correction survey was carried out by 2 surveyors in and around Ootacamund in the Nilgiri district of Madras. Work commenced in the middle of February and continued till the end of June. The party was administered throughout the season from Bangalore. The officer in charge made tours of inspection in December 1938, February, March and April 1939.

116. Personnel.—1 Class I, 4 Class II and 6 U. S. S. officers, 49 surveyors, 5 draftsmen, 2 computers and 5 clerks. 2 Class II and 1 U. S. S. officers and 28 surveyors were employed in the field and on mapping on their return. The remainder were employed on mapping and miscellaneous drawing and computing throughout the year.

117. Areas surveyed.—

271 square miles of 2-inch correction survey.
4,561 square miles of 1-inch supplementary survey.
4,561 square miles of triangulation.

118. Field work was organized as follows:—

Camp (1).—Mr. B. N. Murthy (Class II) and 13 surveyors carried out the 1-inch supplementary survey of 2,278 square miles of Belgaum and Bijāpur districts of Bombay and of the Deccan States in sheet 47 P.

Camp (2).—Mr. P. A. Thomas (Class II) and 13 surveyors carried out the 1-inch supplementary survey of 2,283 square miles of Belgaum and Bijāpur districts of Bombay, of Kolhāpur State and of the Deccan States in sheet 47 P.

Correction survey was carried out by 2 surveyors under the direct orders of the officer in charge of the party.

Triangulation.—Mr. M. A. Faruque (U. S. S.) was detailed for the reconnaissance and triangulation of an area of 4,561 square miles in Belgaum and Sātara districts of Bombay State and the Deccan States in sheet 47 L.

119. Description of country.—The country covered by 1-inch supplementary survey is open undulating plateau with occasional hills and ridges and presented no serious difficulties, technical or otherwise. The Kistna and Ghatprabha Rivers flow from west to east through the middle of the area but are of little value for irrigation. Both have cut themselves deep water courses which offer an obstacle to communication from north to south and the Belgaum-Bijapur road which spans them by two low level bridges affords the only crossings in the sheets surveyed. North and south of both river basins the ground rises gently. Lateral communications are on the whole good although many roads are in a bad state of repair. Such irrigation as there is, is mostly from wells which are generally lined or in rock. There is a considerable number of these in the two river basins; and even on the higher parts of the plateau, though there are fewer wells, there is a good supply of sub-soil water. After two years of drought the area had good rains early in the year. The hills and ridges are generally flat topped with terraced scarps. The higher parts of the plateau often give way abruptly to a belt of rugged stony and broken country with little cultivation but fair grazing which leads steeply down to the cultivated plains below. This was the only type of country in which any difficulty was experienced.

120. Miscellaneous.—A few cases of guinea worm occurred among khalasis. One khalasi was bitten by a snake and was permitted to return to his home. Otherwise the health of the party was excellent and there were no cases of relapse among any of the surveyors who had suffered so severely from malaria in previous seasons in the Agency portions of Madras and Orissa.

121. Recess duties.—Two Primary Mapping Sections under Messrs. B. N. Murthy and P. A. Thomas (both Class II) completed the fair mapping of the 16 one-inch sheets they had been responsible for surveying in the field season. Mr. N. S. Harihara Iyer (Class II) remained in charge of the Drawing Section until he assumed charge of the party. He was relieved by Mr. E. N. Natesan (Class II) who continued the compiled mapping and miscellaneous work of this section and was assisted by Messrs. H. N. Murti Rao, M. L. Kohli, M. A. Azim, and M. W. Kalappa (all U. S. S.). Mr. A. Shamanna (U. S. S.) in charge of the Computing Section computed the season's triangulation and continued with the classification, binding and arrangement of old computations.

Burma Survey Party.

Officer in charge.—Major H. W. Wright, R.E.

122. General.—The year was a difficult one for the party. The framework and fair drawing unfinished in the previous year had to be made good during the open season under report; a large proportion of the supervising staff had been recently transferred and was new to Burma field conditions. Civil unrest and the outbreak of plague in Tharrawaddy district were disquieting elements during the open season.

During the year original records for departmental topographical surveys and maps were received from the Survey of India offices in India, also records of Burma reserved forest surveys and Burma cantonment surveys. The check and storage of these records was put in hand.

Close liaison was established with the Burma Land Records Department, and the latter have adopted many Survey of India technical methods. A beginning was made by the Land Records Department field staff using modern Burma Survey Party theodolite traverse.

Arrangements were concluded with Headquarters, Army in Burma, for the interchange of intelligence information and discussions were initiated in connection with Burma cantonment survey work and the employment of Burman soldier surveyors, in the future.

The Burmanisation of the Lower Subordinate service in the Burma Survey Party continued and the Government of Burma sanctioned the creation of supernumerary appointments for Burman Class II and Upper Subordinate officers.

123. Personnel.—Field strength varied due to a heavy incidence of sickness, mostly malaria, but on an average was 1 Class I, 3 Class II and 4 U. S. S. officers, 31 surveyors and 2 computers. In addition, a Drawing Section under a Class II officer with 2 U. S. S. officers, 12 surveyors, 14 draftsmen, 1 clerk and 1 map record clerk and 5 clerks and 1 store-keeper of party headquarters remained in Maymyo throughout the year.

124. Areas surveyed.—

- 888 square miles of triangulation for 1-inch surveys.
- 375 linear miles of theodolite traversing for 1-inch surveys.
- 51 linear miles of theodolite traversing for forest surveys.
- 1,798 square miles of 1-inch original survey.
- 145 square miles of $1\frac{1}{2}$ -inch original survey for publication on 1-inch scale.
- 480 square miles of 1-inch supplementary survey.
- 137 square miles of $1\frac{1}{2}$ -inch supplementary survey for publication on 1-inch scale.
- 12 square miles of 4, 6 and 8-inch forest survey.
- 145 square miles of 1-inch revision survey.
- 54 square miles of 4-inch revision survey.
- 215 square miles of verification, and survey in modern style, of vegetation.
- 50 square miles of survey in modern style of vegetation.
- 16 square miles of incorporation of vegetation and perennial water information in reserved forest areas the survey of which has already been reported.
- 17 linear miles of reserved forest boundary plane-table traverse on 4-inch scale.

125. Field work was organized as follows:—

Camp (I).—Mr. H. M. Critchell (Class II) assisted by U On Ba, A.T.M., (U. S. S.) with Mr. V. W. H. Raphael, (U. S. S.), and a maximum of 18 surveyors completed 1,098 square miles of 1-inch original survey, 145 square miles of $1\frac{1}{2}$ -inch original survey for publication on 1-inch scale, 248 square miles of 1-inch supplementary survey, 137 square miles of

1½-inch supplementary survey for publication on 1-inch scale, 53 square miles of 1-inch revision survey and 16 square miles of 1-inch survey of vegetation, etc. in sheets 85 O and 94 B in Henzada, Pegu, Tharrawaddy and Toungoo districts.

Camp (2).—Mr. C. T. Hurley (Class II) with a maximum of 11 surveyors completed 700 square miles of 1-inch original survey, 232 square miles of 1-inch supplementary survey and 12 square miles of original large scale reserved forest survey, 92 square miles of 1-inch revision survey, 17 linear miles of reserved forest boundary traverse and 50 square miles of 1-inch survey of vegetation in modern style in sheet 85 N in Henzada, Prome and Tharrawaddy districts.

Camp (3) or Framework camp.—Mr. F. M. Hawley (Class II) with headquarters at Letpadan, with 2 U. S. S. officers one of whom, Mr. A. K. Talapatra took over charge of the camp on 23rd December 1938 and 7 lower subordinates including 2 computers completed 888 square miles of triangulation in sheet 94 B in Toungoo and Salween districts and in Karenni; 3 surveyors from this camp were transferred to plane-tableing in the second week of February. They also ran connection triangulation series across sheets 94 A and 85 M, and carried out 426 linear miles of theodolite traversing in sheets 85 N and O, 94 B and C in Henzada, Pegu, Prome, Tharrawaddy and Toungoo districts. Of this 51 linear miles were boundary traverses of the following reserved forests, Taukkyan, Thakolan, Sathwa in sheet 85 M, Chaungzauk, and Kyatgyi in sheet 85 N in Henzada and Tharrawaddy districts.

Observation of the balance of the 1937-38 framework programme required for the 1938-39 plane-tableing programme was completed and computed in time for use by surveyors.

Experimental work on aneroid barometer heights and plane-table levelling was also undertaken late in March in sheet 94 B in the Pegu district.

During recess 1938 1-inch scale reductions of 4-inch scale Reserved Forest maps were printed in blue on the plane-table sections for completion of survey and inking in full colours in the field.

Incomplete surveys by late No. 11 Party, Survey of India, of the period of the 1930-31 Burma Rebellion were used after revision and completion on the ground.

126. Description of country.—The area surveyed is classifiable in three general categories; forested hills; flat rice fields with many verdurous villages and small towns; and the open 5 to 8-mile wide bed of the Irrawaddy River, which floods this cultivated tract annually and shifts its course during each monsoon by appreciable amounts.

127. Miscellaneous.—Malaria was particularly bad at the beginning of the season; for example, out of eight surveyors in 94 B/2 six went sick and two had to be withdrawn and replaced: five inferior servants died.

128. Recess period.—The fair mapping of all 11 sheets surveyed were completed specially in time to provide maps for the resettlement of Tharrawaddy district: the Drawing Section, increased in strength, under Mr. A. F. Murphy (Class II) completed the fair mapping of 6 sheets of

the 1938 survey programme and carried out the preparation of colour patterns and grid originals, reissue work, compiled mapping, maintenance of office copies and map record and issue duties.

Mr. A. K. Talapatra (U. S. S.) was in charge of framework computations and the preparation of existing departmental and Land Records Department material for use in 1939-40 field operations.

Mr. F. M. Hawley supervised the work of two lower subordinates who carried out 54 square miles of revision survey on the 4-inch scale, in sheets 93 B and C in Mandalay district, for a new edition of the Maymyo Guide Map. He was also in charge of 215 square miles of verification and modern style surveys of vegetation in Kyaukse, Mandalay and Sagaing districts in sheet 84 O and in the Northern Shan States in sheets 93 E and F.

Reissues of maps. A provisional reissue programme was drawn up for more than a thousand sheets covering the whole of Burma. In future the policy will be to reissue maps so far as possible when copies of the existing stock are seriously out of date, rather than to wait till the stock has been exhausted, as has been the practice hitherto.

IX.—MISCELLANEOUS SURVEY REPORTS.

No. 15 Party (Triangulation and Levelling).

Officers in charge.— $\left\{ \begin{array}{l} \text{Captain J. S. O. Jelly, R.E., to 23.2.59} \\ \text{Charge held by D. G. B. from 24.2.59 to 2.4.59.} \\ \text{Captain R. T. L. Rogers, R.E., from 3.4.59 to 6.6.59.} \\ \text{Charge held by D. G. B. from 7.6.59.} \end{array} \right.$

129. The high precision levelling done by this party is described in para. 46.

Secondary Levelling.—94 miles of secondary levelling (one leveller taking 2 sets of observations at each station) were carried out for the Calcutta Corporation from Calcutta via Kultī and Beliāghāta Bridge Railway Station to Dum-Dum in connection with Dr. Dey's Kultī out-fall scheme.

Tertiary Levelling.—414 miles double tertiary, 97 miles partial and control levelling and 2,952 miles single tertiary levelling were executed in Hoshiārpur and Jullundur districts and Kapūrthala States for Punjab Irrigation.

Training School, Dehra Dūn.

Officers in charge.— $\left\{ \begin{array}{l} \text{Charge held by D. G. B. to 7.11.58} \\ \text{Mr. R. T. Wyatt, R.E., from 8.11.58.} \end{array} \right.$

130. *Class II Probationers.*—Eight probationers were appointed in November 1938. They were put through a course of plane-tableing on a large scale and then on the 4-inch and 2-inch scales and short periods were allotted to triangulation, traversing, levelling, astronomy and computations etc.

During the recesses they received further instruction in computing and went through a course in drawing, reproduction and other branches of survey work.

PART 4.—MAP PUBLICATION AND OFFICE WORK.

From 1st April 1938 to 31st March 1939.

X.—INTRODUCTION AND PERSONNEL.

131. Index maps C to G. at the end of this Report, form the most important adjunct to *Part 4*, as they show the progress of publication to date for all standard series of modern maps, excluding transfrontier work.

132. Letter press.—Apart from *Sections X* (Introduction) and *XIV* (the annual report of the Mathematical Instrument Office), *Part 4* is divided into three main Sections:—

Section XI shows all publications and map issues for the year.

Section XII shows all the fair drawing, whether completed for publication or still in hand, carried out by the various drawing offices and field parties.

Section XIII describes the work of the printing and miscellaneous offices, excluding that of the Computing and Tidal Party, whose work is of a geodetic character and is published in full in the annual Geodetic Report.

133. Map Publication Policy.—When the present programme of modern surveys was inaugurated in 1905 it was contemplated that the whole of India would be surveyed and mapped in 25 years and that thereafter revision surveys covering the greater part of the country would take place at regular intervals of about the same period.

In publishing a new map the general policy has been to print sufficient copies to last for about ten years, and on exhaustion of this stock a fresh edition has been brought out incorporating such changes as have been collected from extra-departmental sources of information. As, however, it is in most cases quite impossible to foresee the demand for a particular map over a long period the practice has been to print standard sized editions, generally 500, of all but the more popular topographical maps. In some instances where the demand has been small a large proportion of the original edition is still unsold and is seriously out of date.

The Great War and financial restrictions have delayed the original programme of surveying and mapping and a large part of it is still unfinished, but at the same time many of the modern maps published shortly after 1905 are now out of date.

Recently there has been a demand for up to date editions of maps at more frequent intervals; and this has necessitated an examination of the existing procedure with a view to simplifying and accelerating it. So far no definite decisions have been made as to future policy, but the general lines upon which investigation is being carried out are indicated below.

Up to the present year it has been customary to draw on the same original, details which appear in black, blue and red lines on the published map. This original is photographed and three identical duplicates are made of the photographic negative. From these a negative is made for each colour by 'duffing' or painting out all the work to appear in the other two colours. This process of separating colours is slow and expensive and generally has to be repeated for each new edition as the plate glasses on which the separate negatives are made are cleaned off after the map is published. It possesses however the great advantage

Dehra Dūn. Director, Geodetic Branch.

Colonel C. M. Thompson, I.A.,
to 20-7-38.
Lt.-Col. E. O. Wheeler, M.C.,
from 21-7-38 to 28-2-39.
Lt.-Col. E. A. Glennie, D.S.O.,
from 1-3-39.

No. 2 Drawing Office.

O.C. Mr. D. K. Rennick, M.B.E., to 24-12-38.
" " F. H. Grant, from 25-12-38.
II " Moqimuddin Ansari, B.A.
" " Jugal Behari Lal, to 7-11-38.
" " K. C. Gosain, B.A.

Forest Map Office.

II C. D. Mr. F. W. Smith, to 23-12-38.
" " " J. L. Sahgal, from 24-12-38.
U.S. " " N. C. Ray.

Computing & Tidal Party.

O.C. Major G. Bomford, R.E., to 16-3-39.
" Capt. C. A. Biddle, R.E., from 17-3-39.

Photo-Zinco Section.

Mr. H. J. Psychers,

Letterpress Printing Section.

Mr. H. H. Williams, to 2-1-39 and from 3-3-39.
" Kati Pado Bhattacharjee, from 3-1-39
to 2-3-39.

Simla. Director, Frontier Circle.

Colonel J. D. Campbell, D.S.O.,
to 18-2-39.
Lt.-Colonel W. J. Norman, M.C., R.E.,
from 19-2-39.

No. 6 Drawing Office.

O.C. Captain D. E. O. Thackwell, R.E.,
to 3-11-38.
" Lt.-Colonel W. J. Norman, M.C., R.E.,
from 4-11-38 to 6-3-39.
" Captain D. M. Clementi, R.E., from 7-3-39.

SURVEY SECTION.

II Rai Sahib Chuni Lal Kapur.
" Mr. B. N. Murthy, B.Sc., to 17-4-38.
" " M. D. Nangia, B.A.
" " M. R. Nair, B.A., from 8-8-38.
" " Ghulam Haider Khan, from 17-10-38.
U.S. " Ghulam Hasan.
" " Khushal Khan.
" " G. C. Aggarwala, B.A., to 24-10-38.

ARMY SECTION.

Major T. A. Whitmarsh, H. D., to 25-10-38.
S/Cdr. J. G. Wilson, Offg. H. D., from 26-10-38.

Shillong. Director, Eastern Circle.

Colonel F. J. M. King, to 29-5-38.
" F. B. Scott, I.A. from 30-5-38
to 6-3-39.
Lt.-Colonel T. M. M. Penney,
from 6-3-39.

No. 5 Drawing Office.

O.C. Mr. John McGraken, M.B.E., to 23-12-38.
" " C. H. Tresham, V.D., from 24-12-38.
U.S. " J. R. Chibbar, to 30-1-38.
" " M. M. Shah, to 21-2-39.
" " Mohabat Ali, from 1-10-38.
" " A. K. Maitra, B.A.
" " Muzaffar Husain, C.H., from 1-12-38.

Bangalore. No. 6 (South India) Party.

O.C. Major G. W. Gemmell, I.A.
I Lieut. R. C. A. Edge, R.E., to 2-5-38.
II Mr. N. S. Harilata Iyer.
" " E. N. Natesan, B.A.
" " B. N. Murthy, B.Sc., from 18-4-38.
" " M. R. Nair, B.A., to 22-7-38.
" " P. A. Thomas.
U.S. " H. Narasimha Murthi Rao, B.A.
" " J. A. Cabral, to 4-1-39.
" " Mohabat Lal Kohli.
" " Muhammad Abdul Azim, C.H., I.D.S.M.
" " K. B. Muthanna, to 2-9-38.
" " B. B. Kuttappa, to 21-10-38.
" " A. Shamanna.
" " M. W. Kalappa, B.A., from 20-1-39.
" " M. A. Farnquie, B.A.

Maymyo. Burma Survey Party.

O.C. Major G. F. Heaney, R.E., to 16-1-38.
" " H. W. Wright, R.E., from 17-1-38.
II Mr. A. F. Murphy.
" " H. M. Critchell.
" " C. T. Hurley, from 16-4-38.
" " F. M. Hawley, from 8-4-38.
U.S. " A. K. Sen Gupta, C.H., to 2-1-39.
" " H. K. Kar.
" " A. K. Talapatra, B.A.
" " Muhammad Mustafa.
" U On Ba, A. T. M.
" Mr. S. K. Guha.
" " V. W. H. Raphael, from 2-10-38.

XI.—PUBLICATIONS AND ISSUES.

135. Publications.—The publications of the Department for the year are shown in the following three tables, of which Table I shows map publications at the various presses, Table II shows the progress made in publication of modern topographical and geographical maps, and Table III shows the more important letterpress publications.

Table I(a)—Maps published at Calcutta, during the year 1938-39.

Class of maps.	Scale.	New publica- tions.	Revised editions, new edi- tions and reprints.	Number of copies printed.	Value. Rs.
GENERAL MAPS.					
Maps of India ...	Various	1	3	10,845	26,527
GEOGRAPHICAL MAPS.					
India and Adjacent Countries Series ...	1:1 million	...	18	6,247	9,143
Carte Internationale du Monde ...	"	...	19	4,423	9,149
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern ...	1"=4 miles	8	22	18,664	20,190
" (Prely.) ...	"	...	1	108	108
" (Provl.) ...	"	...	3	1,037	1,076
Half-inch, Modern ...	1"=2 miles	21	10	16,000	22,748
One-inch, Modern ...	1"=1 mile	41	138	97,084	1,47,705
" (Prely.) ...	"	...	3	1,858	2,609
" (Provl.) ...	"	...	1	508	508
Old style maps ...	Various	...	6	1,019	1,542
SPECIAL MAPS.					
Provincial maps ...	Various	...	6	1,936	3,413
City & Town Guide maps ...	"	...	4	817	1,874
Index maps ...	"	...	57	28,014	2,892
Miscellaneous maps ...	"	42	39	99,704	11,908
Total ...	.....	113	329	283,354	2,61,622
Extra-departmental.					
Manœuvre and Radius maps ...	Various	...	8	2,241	4,656
Other maps ...	"	133	40	42,597	22,637
Plans and diagrams ...	"	103	7	15,750	2,873
Illustrations ...	"	158	...	52,967	8,376
Miscellaneous ...	"	41	18	213,824	4,865
Total ...	.....	435	73	327,385	43,507
Maps published for the Govt. of Burma.					
General & Geographical maps ...	Various	...	2	823	1,819
Topographical maps ...	"	18	32	21,073	37,818
Special maps ...	"	...	1	1,018	751
Total for Burma ...	.....	18	35	22,914	40,388
Total Extra-departmental ...	.....	453	108	350,299	83,895
Grand Total ...	.....	566	437	633,653	3,45,517

NOTES.—*Calcutta.*—In addition to the work shown in Table I(a), 10,619 copies of 113 maps were gridded during the year.

Table I (b)—Maps published at Dehra Dūn.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Cantonment maps ...	Various	...	71	10,263	5,715
Forest maps ...	4"=1 mile	3	5	905	570
Miscellaneous ...	Various	59	39	32,029	8,368
Total ...	...	62	115	43,197	14,662
<i>Extra-departmental.</i>					
Maps ...	Various	42	40	4,896	5,938
Plans and diagrams ...	"	32	20	7,777	1,031
Charts ...	"	33	47	6,899	3,038
Forest maps ...	"	8	...	1,183	2,131
Total ...	...	115	107	20,754	12,138
Burma maps (Cantonment & Forest) ...	4"=1 mile	...	3	156	214
Total Extra-departmental ...	...	115	110	20,910	12,352
Grand Total ...	...	177	225	64,107	27,014

NOTES.—*Dehra Dūn.*—In addition to the work shown in Table I (b) above, 2,477 prints of 337 originals, consisting of plane-table sections, triangulation charts and forest maps, &c. were printed. 17 bromide prints, 4 halftone blocks and 16 line blocks were also printed, and 225 prints of 79 originals for the Burma Survey Party.

Table I (c)—Maps published at Quetta.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Maps ...	Various	...	7	38	71
Plans and diagrams ...	"	3	2	10	4
Charts } Forms }	"	6	10	4,419	161
Total ...	...	9	19	4,473	236
<i>Extra-departmental.</i>					
Maps ...	Various	2	...	42	63
Plans and diagrams ...	"	3	14	1,559	268
Charts } Forms }	"	1	...	100	11
Total ...	...	6	14	1,701	342
Grand Total ...	...	15	33	6,174	578

Table I(d)—Maps published at Murree and Risālpur Cantonments.

Class of maps.	Scale.	New publica- tions.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Maps	Various	...	...	3,242	3,333
Plans and diagrams ...	"	...	...	273	201
Charts } including pano- Forms } ramas	"	...	...	5,085	483
Total ...	...	...	...	8,600	4,017
<i>Extra-departmental.</i>					
Maps	Various	...	...	1,428	614
Plans and diagrams ...	"	...	...	1,025	111
Charts } including pano- Forms } ramas	"	...	...	1,054	234
Total ...	...	...	...	3,507	959
Grand Total ...	...	...	...	12,107	4,976

Table II.—Abstract of Modern Topographical and Geographical Maps.

	INDIA.						BURMA.					
	1"	1/2"	1/4"	1/M		1/2 M	1"	1/2"	1/4"	1/M		1/2 M
				I. & A. C.	Carte Inter- nationale.					I. & A. C.	Carte Inter- nationale.	
Primary sheets pub.	3,244	218	23	.....	.....	.....	612	25	.....	.....	.....	.....
Compiled sheets pub.	.....	751	276	*75	20	14	.....	161	53	*8	1	.....
Remaining (Approx.) ...	860	450	131	.....	21	6	260	70	20	.....	5	.....
Totals (Approx.) ...	4,100	1,420	430	.....	41	20	870	260	73	.....	6	.....
Transfrontier sheets published.	.....	.....	154	.....	.....	.....	.....	.....	4	.....	.....	.....
Grand total (Approx.) ...	4,100	1,420	584	.....	41	20	870	260	77	.....	6	.....

* This series has been abandoned and no new sheets will be taken up.

Table III.—Letterpress publications.

(a) PUBLISHED AT CALCUTTA.

1. General Report of the Survey of India, 1938. (440).
2. Supplement to the Survey of India Reports, 1938. (130).
3. Survey of India Notes,—issued monthly. (3,000).
4. List of Maps Published,—issued monthly. (4,800).
5. Supplementary List of Maps Published,—issued quarterly. (2,000).
6. Handbook of Topography, Chapter X (4th Provl. Issue). (400).
7. Government of India Orders. (1,250).
8. Corrigenda to Circular Order Nos. 397 & 422 (Administrative). (1,200).
9. Correction slips to Handbooks of Topography, Border Specimen, etc. (39,050).
10. Calendars for 1939. (1,400).
11. Miscellaneous. (367).

(b) In hand at Calcutta.

1. Correction slips to Handbooks of Topography, Border Specimen, etc.
2. Government of India Orders, etc.
3. Circular Orders, etc.
4. Halftone Blocks.
5. Line Blocks.
6. Rubber Stamps.
7. Miscellaneous Departmental forms.

(c) PUBLISHED AT DEHRA DŪN.

1. Geodetic Report, 1937. (350).
2. Tide Tables for the Indian Ocean, 1939. (1,200).
3. Tide Tables, Hooghly River, 1939. (225).
4. Do. Bombay, 1939. (875).
5. Do. Rangoon River, 1939. (800).
6. Auxiliary Tables III. (300).
7. Handbook of Topography, Chapter II. (150).
8. Handbook of Topography, Chapter IX. (75).
9. Takhte-wālon ke liye Hidāyat. (1,000).
10. Professional Paper Nos. 28 and 29. (700).
11. Supplement to Geodetic Report, 1937. (125).
12. Addendum to Geodetic Report, 1937. (100).
13. Levelling Pamphlet 48. (100).
14. Supplement to Levelling Pamphlet 47. (100).
15. Addendum to Levelling Pamphlets. (300).
16. Secondary Levelling Pamphlets (Gestetnered). (85).
17. List of Bench-marks. (12).
18. Correction slips to Handbooks of Topography, Auxiliary Tables and Pamphlets, (3,190).
19. Miscellaneous. (284,816).

(d) In hand at Dehra Dūn.

1. Geodetic Report, 1938.
2. Levelling Pamphlets 41 and 34.
3. Report on Geodetic work to the International Union of Geodesy and Geophysics.
4. Auxiliary Tables II.
5. Miscellaneous.

136. Map Issues.—It will be seen from Table IV below that the total sales by the entire department during the year 1938-39 were 519,939 copies, value Rs. 2,63,680 as against 721,992 copies, value Rs. 2,91,144, sold during the previous year.

The Map Record and Issue Office's total sales of departmental maps were 140,457 copies, value Rs. 1,56,324, as against 199,881 copies, value Rs. 1,96,302, sold during the previous year. The decrease is due to

Note.—Numbers in brackets after each item denote the number of copies printed.

the curtailed demands of the Army who purchased roughly 62,000 maps less this year.

The total number of extra-departmental maps issued by the Map Record and Issue Office was 348,935 copies, value Rs. 82,803.

The number of maps transferred to the High Commissioner for India, London and the Circle Offices for stock and issue was 29,087 copies, value Rs. 44,931.

Table IV.—Maps issued by Survey units.

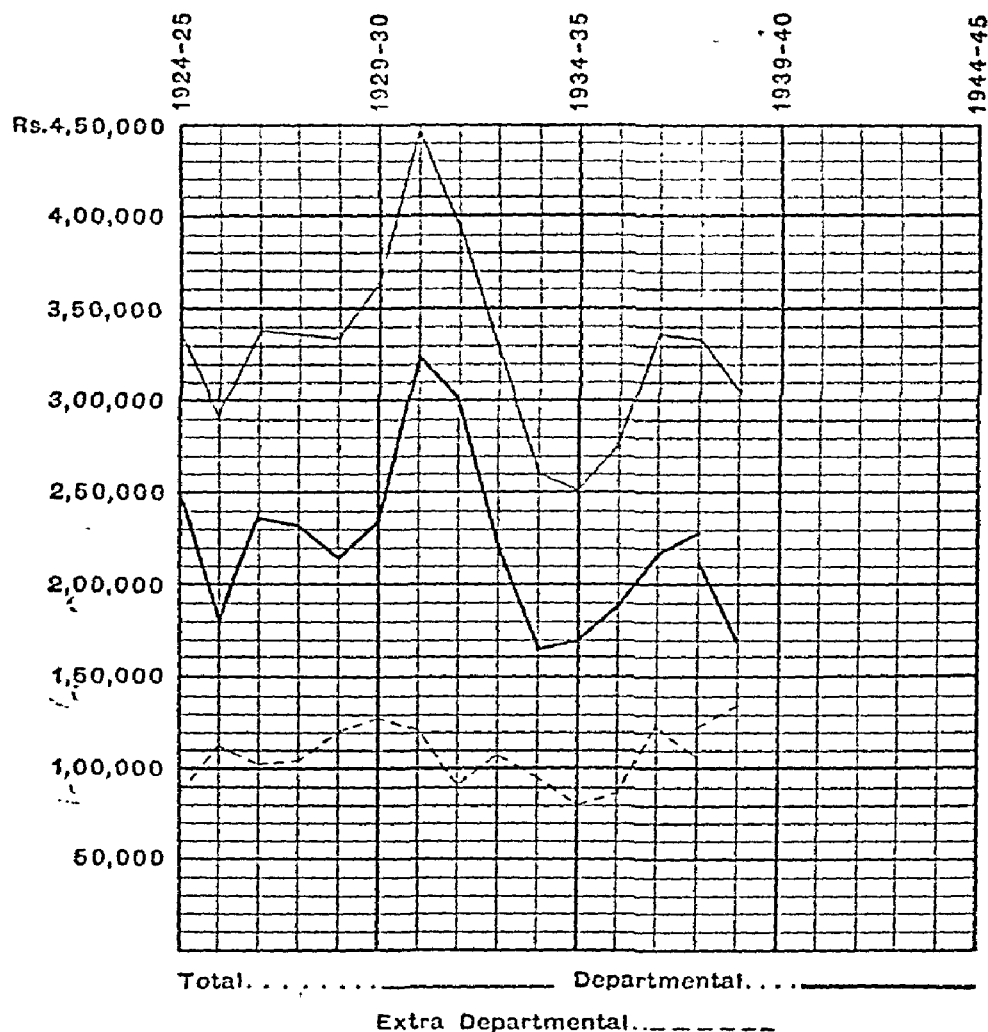
D=Departmental. X=Extra-departmental.		SALES.								FREE ISSUES.
		GOVERNMENT OFFICIALS.		ARMY AND ROYAL AIR FORCE.		PUBLIC.		TOTAL.		Number of copies.
		Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	
Calcutta	D	24,157	31,893	69,953	62,161	46,337	62,270	140,457*	1,56,324*	10,841
	X	301,427	27,307	5,956	4,247	18,639	10,861	326,021	42,415	1,947
Dehra Dun	D	1,640	3,006	2,187	2,257	1,075	1,625	4,902	6,888	8,711
	X	11,531	8,397	404	175	3,403	926	15,338	9,498	100
Simla	D	182	204	10	23	196	337	338	564	682
	X	....	.....	.....	.....	....	.....	.....	.....	..
Murree and Lahore ("A" Company)	D	11	20	6	6	3	9	20	35	759
	X	..	.....	.....	.....	..	...	..	.....	....
Quetta and Karachi Cantonnments ("E" Company)	D	197	338	1,570	1,080	518	774	2,085	2,192	293
	X	1,454	197	180	103	117	42	1,701	342	... ..
Murree and Risalpur Cantonnments (No. 18 Party)	D	.....	.....	.....	.....	....	.....	.....	.....	8,600
	X	.....	.....	3,507	959	... ..	..	3,507	959	.. ..
Bangalore	D	207	385	105	177	1,620	2,348	1,932	2,910	264
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shillong	D	353	539	76	72	280	454	709	1,065	1,125
	X	15	100	.....	.....	.....	.....	15	100	.....
Totals (excluding Burma maps).		341,134	72,386	83,704	71,260	72,187	79,646	497,025	2,23,292	33,322
Calcutta, (Burma maps) X		22,914	40,388	..	.....	... ..	.. ..	22,914	40,388	.....
Grand Total ...		364,048	1,12,774	83,704	71,260	72,187	79,646	519,939	2,63,680	33,322

* Excludes 29,087 copies of maps, value Rs. 44,931 issued by the Map Office, Calcutta to the High Commissioner for India and the Survey Circles and Parties, for stock and sale.

Note.—In this table the figures in the sale-value columns exclude the cost of mounting in various linen-backed styles.

PROGRESS OF MAP SALES

1924-39.



NOTE:—The break in Departmental and Extra Departmental graphs after the year 1937-38 indicates the change over of Burma maps from Departmental to Extra Departmental.

The above graph represents the aggregate sales of the whole Department. These figures include the cost of maps supplied in various linen-backed styles.

137. Map Record and Issue Office.—The fall in the sale proceeds of maps is due to a decrease in Army demands; the interest of the public however continues to grow, 46,337 departmental maps having been purchased as against 40,274 in the previous year. The relative distribution of maps to our principal purchasers, noted below, shows a more general appreciation of the utility of Survey of India maps. This is further indicated by the receipt in this office of 17,492 orders and enquiries as against 16,766 in the previous year.

	1936-37	1937-38	1938-39
ARMY AND AIR FORCE ...	70 %	67 %	50 %
GOVERNMENT OFFICIAL ...	18 %	12 %	18 %
PUBLIC ...	17 %	21 %	32 %

Excluding the value of maps held by the Circle Offices and the Branch Agency at Calcutta, the approximate value of the MAP RECORD AND ISSUE OFFICE stock on 31st March 1939 was Rs. 29,42,574.

Physical verification of stock was carried out under the direct supervision of the Officer in Charge, Map Record and Issue Office, at frequent intervals throughout the year.

XII.—WORK OF DRAWING OFFICES.

138. No. 1 Drawing Office, Calcutta.—Verification on the ground of the numerous corrections to the "Calcutta and Howrah Guide Map" and also a general revision of the whole map was undertaken with the aid of surveyors lent by the Eastern Circle. The results of these surveys are now being embodied on prints from the engraved plates with a view to the issue of a revised edition. It is proposed to keep two surveyors in No. 1 Drawing Office who will annually carry out correction surveys and keep the originals of the above guide map up-to-date and so facilitate the issue of a new and up-to-date edition every two years.

The drawing of the revised edition of the 50-mile Road Map of India was completed and only examination of some details remains.

The drawing of the Province maps of "Bihār", "Delhi" and "Kashmir & Jammu" was completed and only supplementary work for publication remains.

Work on the 40-mile Map of India and Adjacent Countries continued.

Work on all the sheets of the new 1/M series allotted to No. 1 Drawing Office has been started and it is hoped to send some sheets for publication before the end of the year.

The *Engraving Office* has been kept busy on preparing alphabets in different sizes and styles in connection with the scheme for the introduction of photo-lettering. It has been found that alphabets do not stand more than a certain amount of reduction and that for photo-lettering "master" alphabets of different sizes for each style of lettering are required.

139. No. 2 Drawing Office, Dehra Dūn.—The following extra-departmental special maps have been published during the year under report:—

- (a) A "Lay-out Plan of New Delhi" with an out-rigger showing the area of the Imperial Agricultural Research Institute on scale 6"=1 mile, for the Superintending Engineer, Central P. W. D., New Delhi.
- (b) A map of "Bhopāl Northern Military Training Area" on scale 1"=1 mile, for the General Staff Officer, Bhopāl State Forces.

The following extra-departmental maps are in hand:—

- (a) An "I. M. A. Training Map" on scale 1:25,000 for the Indian Military Academy, Dehra Dūn.
- (b) A map of "Bhopāl Southern Military Training Area" on scale 1"=1 mile, for the General Staff Officer, Bhopāl State Forces.

As a result of the decision made by the Conference on Map Policy which assembled at New Delhi in December 1937 to publish and maintain an up-to-date series of the 1/M *Carte Internationale du Monde* with aeronautical and unlayered editions which will replace the present

India and Adjacent Countries series, one section of the Drawing Office was entirely employed on preparing the basic compilations and drawing separate colour originals for the 1/M maps allotted to the Geodetic Branch.

The modernization and bringing up-to-date of $\frac{1}{4}$ -inch Irān sheets has been temporarily held up with a view to bringing out the new 1/M International maps as early as possible.

140. Forest Map Office, Dehra Dūn.—This office, which is maintained by contributions from the Provincial Governments of Bombay, Central Provinces and Berār, Madras and the United Provinces of Āgra and Oudh and the Government of Burma, continued to meet all demands from these Governments for forest maps. Its main work is the fair drawing of working plans and new editions for various forest officers and the maintenance of the office copies for these provinces, (Burma keeps up its own office copies). In addition, it does paid-for work for non-contributing provinces and Indian States. As a result of the secession of Burma the contribution from that Government ceased on 31st March 1939.

141. Map Record and Business Section, Dehra Dūn.—This section continues to be responsible for the storage, despatch and sales of publications and forms, and for the collection of bills for all supplies and extra-departmental maps published, and for paid-for work carried out in the Geodetic Branch; it stores all originals of departmental maps published in Geodetic Branch and of cantonment and forest maps with their published prints, and carries a small stock of Survey of India maps for issue within the department and for sale to the public. All prints, records and originals pertaining to Burma have been transferred there on its separation from India.

142. No. 6 Drawing Office, Simla.—

Survey Section.—

- (1) The following work was done in addition to that reported in Tables VI to VIII:—

Indexes.—A large number of miscellaneous indexes were prepared.

General.—(a) Frontier Circle records were received from parties and other circles and were indexed and arranged.

(b) At the request of the Director of Civil Aviation, 28 traces of landing grounds were prepared and supplied to him.

(c) Sheets 44 A/9, 44 A/13, 38 L/15 (outline originals redrawn, old contour originals corrected and green tree originals newly prepared) were submitted to the Director, Map Publication for publication.

(d) The Simla Guide Map was reissued, after revision in the field, by correcting black prints on white enamel of the various colour plates.

(e) Appliqué slip of 43 M for reissue was drawn and submitted to the Director, Map Publication.

(2) This section also carries a stock of Survey of India maps for issue within the department and for sale to the public and other departments.

Army Section.—

During the year, the Army Section was employed in the compilation, drawing and reproduction of maps, plans and diagrams for the Army and various other Departments of the Government of India.

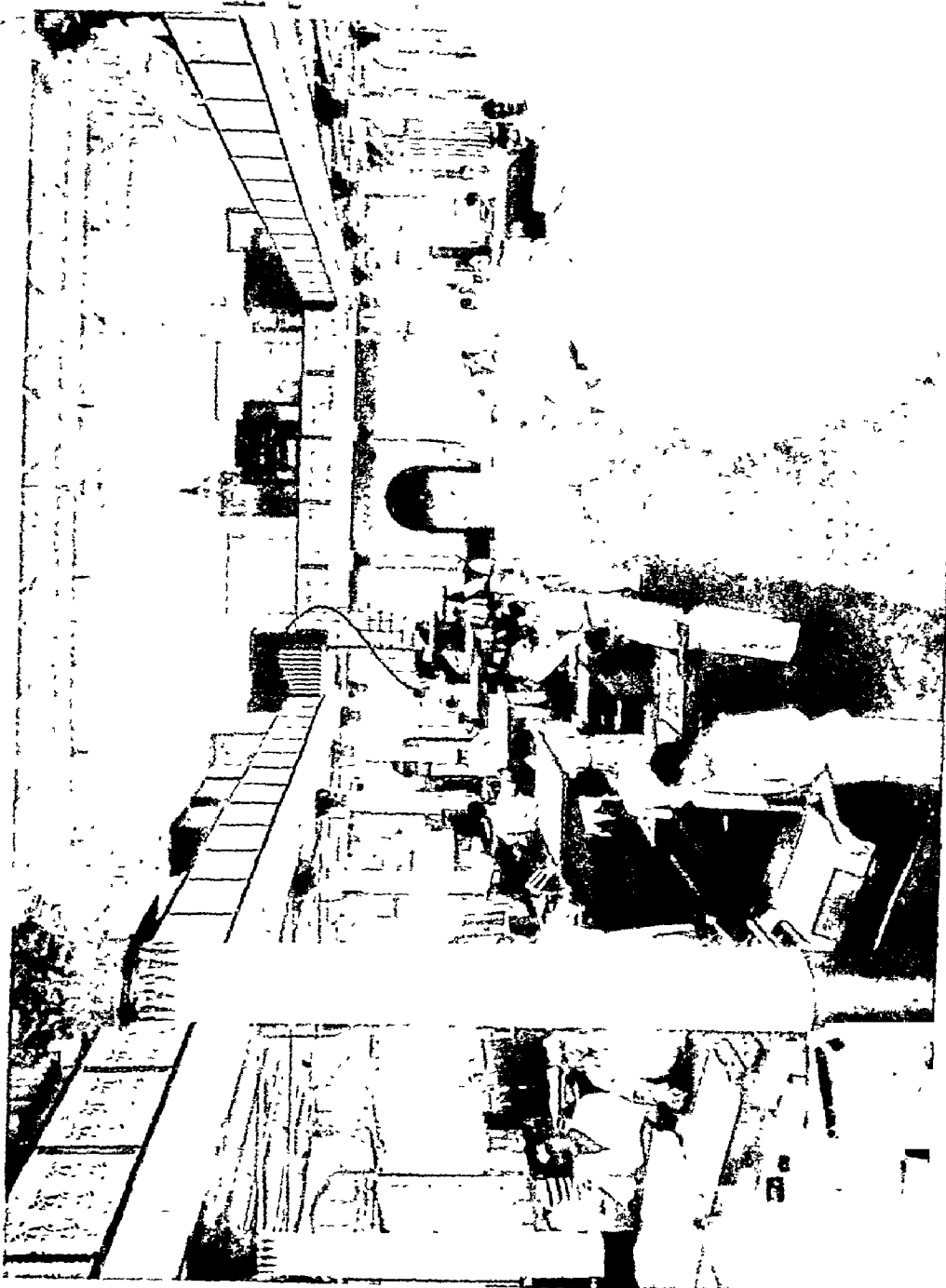
The output of work of the Vandyke and reproduction sections continues to be high.

Many jobs are being printed in as many as five colours.

In addition to the normal routine work, 7 British other ranks were trained as draughtsmen for employment in the Army.



RETOUCHING NEGATIVES
FOR MAP REPRODUCTION.



PRINTING SECTION,
LITHO. OFFICE.

XIII.—PRINTING AND MISCELLANEOUS.

143. The Photo.-Litho. Office, Calcutta.—The year under report is the fiftieth year of the Photo.-Litho. Office in its present form. The building at 14, Wood Street, Calcutta was built to the design of Major-General James Waterhouse, I.A., the eminent photographer, who was in charge of the reproduction activities of the department from 1874 to 1897, and was opened by him in September, 1889. Considerable forethought was displayed in its planning and only very minor additions and alterations have been necessary in the fifty years following its construction.

The amount of work received during the year was a little below the average of the last few years. The number of half-tone blocks has greatly decreased, partly on account of a general decrease in demand due to financial stringency and outside competition, and partly because the process-engraving section has been much taken up with photo.-lettering research. Furthermore some of the work previously carried out with half-tone blocks is now printed by litho. offset machines from deep-etched zinc plates.

Elimination of Distortion.—All fair drawing sheets this year were mounted on aluminium foil, using a shellac adhesive. It has been found, however, that during the monsoon blisters develop and the paper begins to leave the foil. Clearly therefore this foil-mounted paper is unsuitable for permanent records. Experiments in foil-mounting continue and a proposal to have paper sent out from England ready mounted, using a plastic adhesive, is being considered. This would have the advantage that mechanical mounting devices not available in India could be used, and a more perfect result obtained. It has been found, however, that foil sheets thus mounted are not free from distortion.

Anodised aluminium, (that is, aluminium the surface of which has been rendered resistant to deterioration by an electrolytic process), cellulose sprayed metal, and a transparent plastic called Perspex have all been tried as substitutes for paper for fair-drawing. These materials will all take photographic, or cyanotype, blue prints which are free from the distortion to which blue prints made in a lithographic machine are prone, but it is doubtful whether sufficient reliance can be placed on the stability of the two last materials for their use for permanent records. Anodised aluminium, however, has all the necessary durability, though fair drawing on stiff sheets of this metal may require a special technique. Typing is not possible on anodised aluminium, coated metal or Perspex, and until photo.-lettering becomes a practical proposition names will have to be typed on foil-mounted paper. In any case it is felt that the expense of non-distorting materials other than foil-mounted paper may limit the extent of their adoption for the present.

Supplementary non-distorting records are now being made in Photo.-Litho. Office in the shape of black helios on caustic-grained aluminium from the separated colour negatives of standard sheets.

New apparatus and Buildings.—Owing to financial stringency the improvements mentioned under this head in last year's report have been postponed.

Photo.-lettering.—Photo.-lettering has been further developed during the past year. In this process names for maps are produced photographically, and it has the following advantages over the present method of typing:—

- (i) The quality of lettering is better.
- (ii) It can be used with metal, enamel or similar hard non-distorting fair drawing surfaces upon which typing is impossible.
- (iii) The Engraving Office can produce the originals from which photo.-lettering alphabets are made, and choice of lettering styles is therefore unlimited.

It is hoped eventually that it will be possible to apply the process to all the topographical maps produced by the Survey of India, though at present it is not sufficiently developed to make this an economic proposition.

Experiments at present are mainly concerned with the development of a "positioning camera". This means a camera which can photograph every name on a map directly down into its correct relative position. This problem presents many technical difficulties and so far three experimental cameras have been constructed in the Mathematical Instrument Office and tried, while a fourth is under construction.

If this last camera should prove satisfactory, it may be possible to introduce photo.-lettering for routine work by the middle of 1940.

COST AND OUT-TURN OF PHOTO.-LITHO. OFFICE.

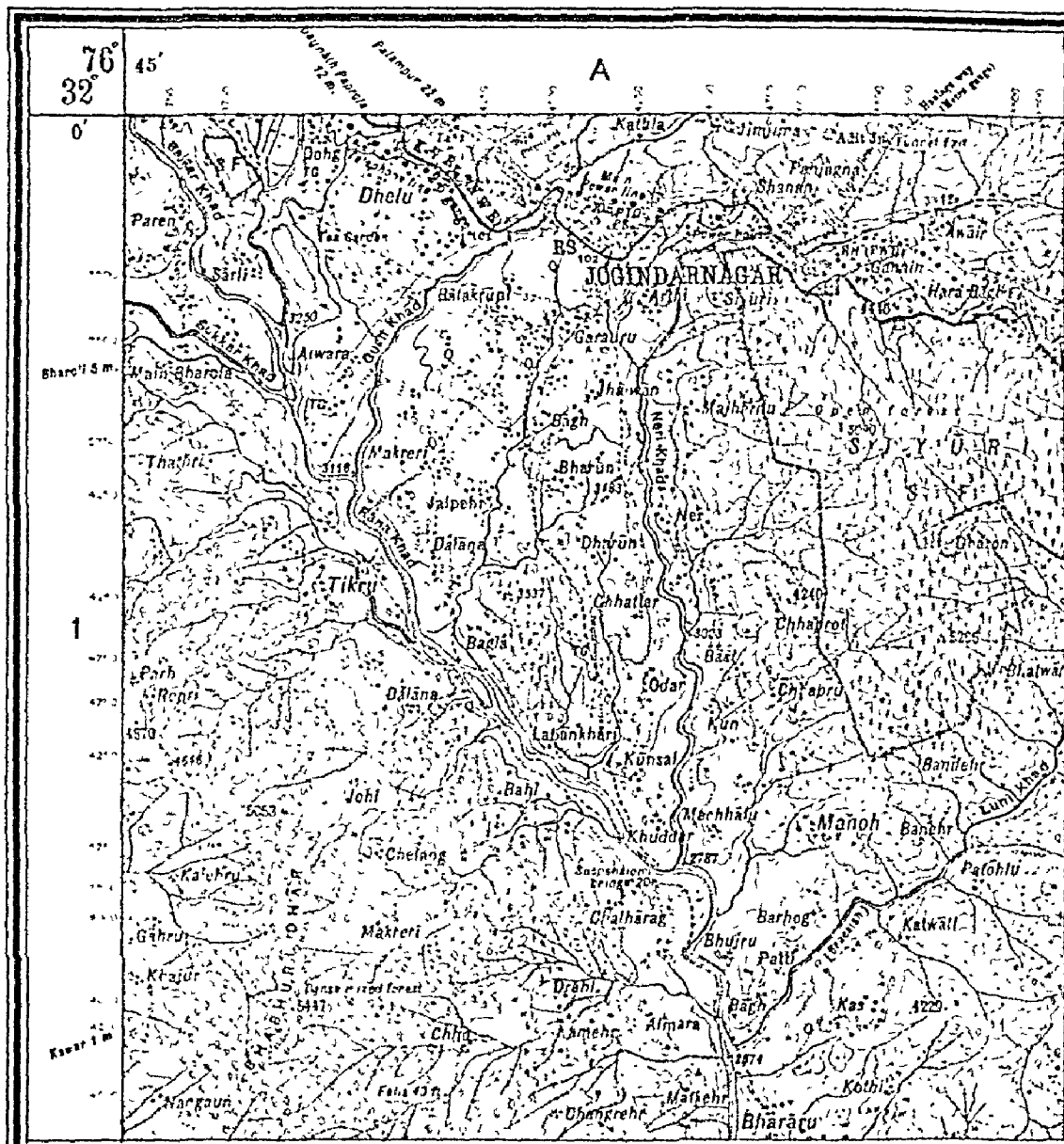
Expenditure.	Value of out-turn at office rates.	Negatives prepared.	Zinc plates prepared.	MAPS PRINTED.			Impressions pulled.
				Departmental.	Extra-departmental.	Barma.	
Rs.	Rs.						
3,26,003	3,12,430	5,285	5,809	689	1,948	49	3,127,172

INDEPENDENT OUT-TURN OF THE PROCESS-ENGRAVING AND TYPE-PRINTING SECTIONS.

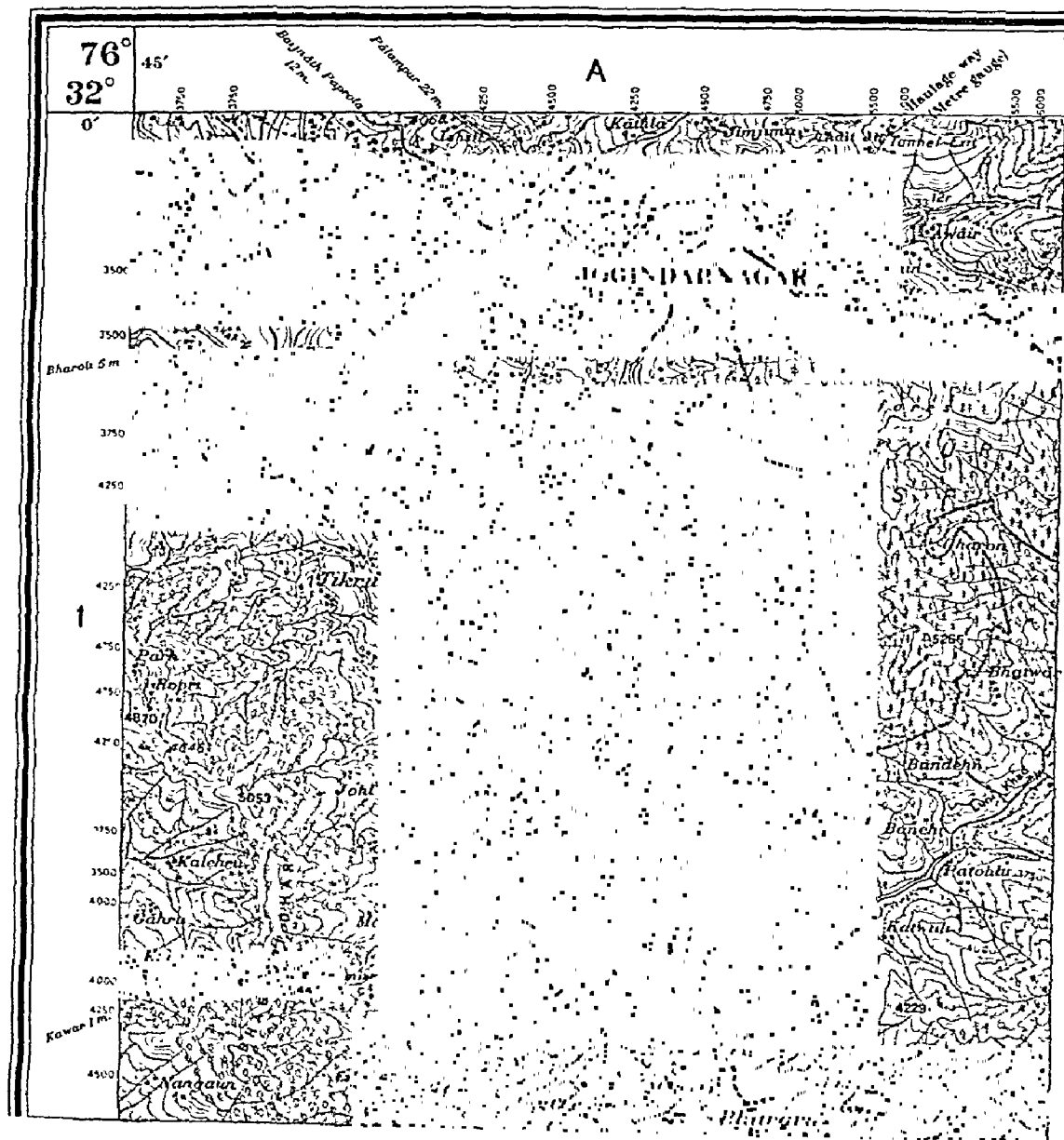
PROCESS-ENGRAVING SECTION.					TYPE-PRINTING SECTION.		
HALF-TONE WORK.		LINE WORK.		PHOTO-ENGRAVING.			
Blocks prepared.	Impressions pulled.	Blocks prepared.	Impressions pulled.	Plates prepared.	Items or pages published.	Copies printed.	Impressions pulled.
65	23,568 (Impressions of 333 blocks).	49	39,500 (Impressions of 27 line blocks).	.....	1,641	919,856	2,026,257

KANGRA DISTRICT. MANDI STATE.

Surveyed 1935-36.



PORTION OF SURVEY OF INDIA SHEET 53 A/13 SCALE 1-INCH TO 1-MILE WITH TYPED LETTERING.



THE SAME MAP WITH PHOTO-LETTERING.

The style of lettering in this specimen is one of several under consideration; the final selection has not yet been made. The technique of preparing the map originals is also still in the experimental stage.

**OUT-TURN OF ENGRAVING OFFICE COPPER PLATE
PRINTING SECTION.**

IMPRESSIONS PULLED.				
Photogravures.	Chromo Paper.	Transfer.	Miscellaneous.	Total.
11	253	273	4,734	5,271

144. Photo-Zinco. Section, Dehra Dūn.—The printing plant of this section consists of one rotary and two flat-bed machines (only one of which is in use at a time). An offset press and three hand presses were in continuous operation during the year printing cantonment and forest maps, diagrams and charts. The Naini Tal Guide Map, Lay out plan of New Delhi and the map of the High lands of Tibet and Surrounding Regions were printed in colours.

A new "Ditto" duplicating machine has been recently purchased for the printing of diagrams and drawings etc. in several colours in one operation.

The machine is being tried out with a view to adapting it to the requirements of the Department and will then be transferred for use in the Frontier Circle.

145. No. 18 (Air Survey) Party, Murree and Risālpur.—The Reproduction Section was employed on miscellaneous work throughout the year.

The following presses are in use in 18 Party:—

Two D. E. handpresses.

One Imperial handpress.

One Furnival Portable handpress—23 inches × 21 inches.

Reproduction of originals received:—

In one colour	...	...	...	363
In two colours	...	...	...	36
In three "	...	...	...	5
In four "	...	...	...	1
Vandyke and helio plates prepared	...	...	...	310
Prints pulled	...	...	...	12,107

146. "E" Survey Company, Karachi.—The Reproduction Section remained attached to this unit up to October 1938, when its personnel were transferred to other offices. All reproduction plant has been transferred to No. 18 (Air Survey) Party at Risālpur, except the rotary and the duplicating presses which will be removed during May 1939. The value of the extra departmental jobs carried out by the Reproduction Section was Rs. 637-12-0.

Reproduction of originals received:—

In one colour	...	...	...	10
Vandyke and helio plates prepared	...	...	...	8
Prints pulled	...	...	...	1,701

XIV.—MATHEMATICAL INSTRUMENT OFFICE.

147. Manufactures, Repairs and Issues.

The year under review shows a further marked increase in the sale of instruments, output of the workshops and the range of scientific instruments manufactured and repaired.

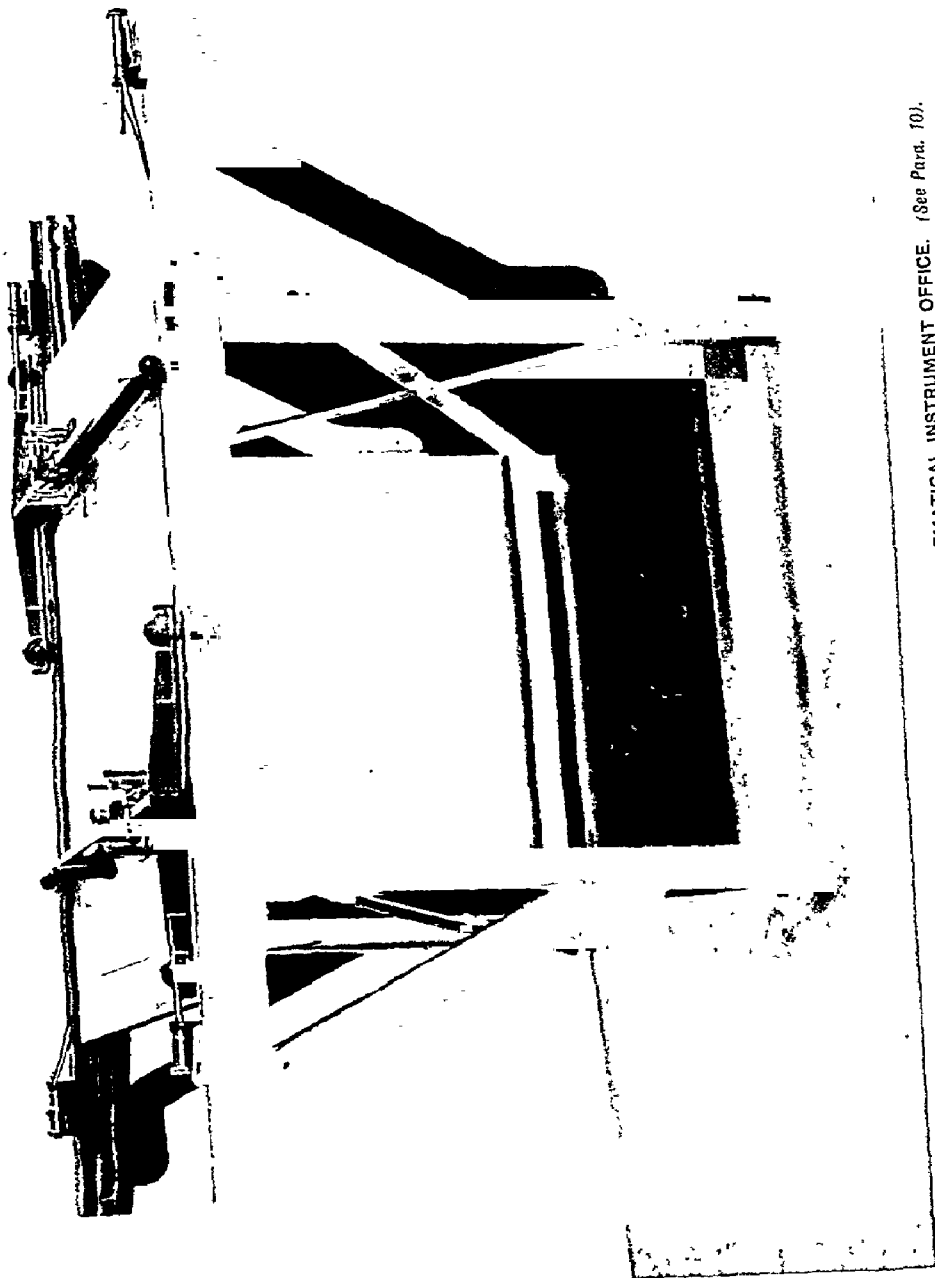
The principle items manufactured and repaired are as under:—

Manufactures.

Plane-tables	... 346	Protractors circular metal	4
Plane-table stands	... 316	Scales & offsets boxwood	4,214
Plane-table covers	... 309	„ „ cardboard	3,705
Haversacks, canvas	... 218	and mica.	
Drawing boards	... 241	„ set boxwood	... 70
T-squares	... 156	Sight rules wooden and	398
Levelling staves	... 202	brass of sorts.	
Stereoscopes, head type	4	Steel band chains	... 59
M. I. O.		Measuring chains	... 467
Stereoscopes folding	59	Ferrotypes printing frames	10
mirror, without mono-		Set squares celluloid	... 431
oculars.		„ ebonite	.. 1,135
Survey umbrellas	... 103	„ set of 9	... 40
Raingauges	... 122	Brass, hydrometers sets	227
Prismatic compasses with	38	Clinometers modified	70
stands.		pattern.	
Pantographs	... 7	Hygrometers Factory	41
Leather cases for tapes	... 3,071	pattern.	
Mason's levels	... 91	Thermometers	... 381
Straight edges	... 21	Water bottles	... 50
Protractors circular and	64		
semi-circular, celluloid.			

Repairs.

Levels with stand	... 277	Measuring tapes	... 156
Theodolites	... 76	Station Pointers	... 9
Pantographs	... 4	Drawing-Instrument	127
Levelling staves	... 15	sets.	
Plane-tables	... 3	Parallel Rules	... 36
Bubble tubes	... 66	Barometers	... 18
Sight Rules	... 36	Calorimeters	... 1
Ophthalmoscopes	... 3	Planimeters	... 43
Sphygmomanometers	... 2	Compasses	... 123
Watches	... 55	Microscopes	... 69
Clocks	... 14	Refractometers	... 8
Polariscopes	... 3	Kenotometers	... 2



CO-ORDINATOGRAPH MANUFACTURED IN THE MATHEMATICAL INSTRUMENT OFFICE. (See Para. 10).

The Optical Repair Section re-worked, re-polished and re-balsamed 92 lenses and 195 prism. surfaces. In addition the following were manufactured:—

Lenses	...	907	Graticule glasses	...	15
Prisms	...	73	Reflector mirrors	...	220
Diaphragm glasses	...	412	Steel mirrors, optical planes		12
Colour glasses	...	285	Mirrors signalling	...	79

In the Glass Graduation Section, 426 rain measure glasses, $\frac{1}{2}$ " and 1", and 1,102 glass jars for excise purposes were graduated.

The Glass Blowing Section manufactured 381 thermometers, 41 factory pattern hygrometers, and 127 glass spirit bubbles of various kinds. It repaired and adjusted 199 thermometers of various types, 109 excise hydrometers, and 57 hygrometers.

Aviation Work. In the Compass Repair Section, 9 Aero-compasses were repaired. During the year repairs to other aircraft instruments were undertaken for the Director of Civil Aviation in India, such as Air Speed Indicators, Altimeters, Turn and Bank Indicators, Oil Gauges, Revolution Indicators, Flying Time Logs, Level Indicators. In order to cope with this work a new section is being arranged in the works and the necessary test apparatus is under manufacture. A wind tunnel 10 ft. by 2 ft. internal diameter is under construction. This will be used in conjunction with suitable standard instruments to maintain varying air pressures for the testing and calibration of aircraft instruments.

The following stores were manufactured and supplied to various sections of the Defence Department during the year:—

- 245 Lenses, double, convex.
- 227 Plates, instruction, phonetic alphabet, brass, in accordance with drawing H. & S. F 747 (sheet No. 1).
- 5 Bubbles, glass 'L' Mk. I, 1.6" × .3".
- 1 Protractor R. A. 9" as per drawing CIA (OS) 646.
- 238 Labels, metal, instruction, brass.
- 800 Cords (cord plaited, cotton water-proofed .08 in circumference × 24½" long).
- 1,200 Beads (Beads, Zylonite, oval .17" dia. × .2" long, for rules, slide Mk. III).
- 80 Romers.
- 60 Lamp, signalling, D.L., Projector Mk. II S. R. D. S, reflector mirrors.
- 43 Rules, natural colour 5 ft. long (2-fold).
- 459 Tapes, of sorts, in M. I. O. leather cases.
- 12 Compasses, prismatic, liquid, Mk. II Barker's, in case.

- 12 Staves, levelling.
- 65 Celluloid sheets, transparent, $13\frac{1}{4}" \times 9\frac{1}{2}"$.
- 27 Flags, surveying, with 8ft. bamboo rods.
- 79 Boards, drawing.
- 17 Plane-tables.
- 18 Stands for plane-tables.
- 18 Rules, parallel, on rollers, brass and electrum, of sizes.
- 9 " " bar, ebonite, 18".
- 260 Set squares, single, ebonite.
- 105 " " " celluloid.
- 12 Sets squares, set of 9, ebonite, in case.
- 360 Scales and offsets, single.
- 17 Scales, of sorts, sets.
- 2 Glasses, copying or tracing, in box.
- 40 Stereoscopes, folding mirror, without monoculars, M. I. O. improved pattern.
- 63 T-squares.
- 78 Thermometers.
- 67 Pens, drawing, lifting nib.
- 6 Ferrottype Printing Frames.

148. Distribution of transactions.—The value of invoices covering transactions with various Government departments etc. during the year is as follows:—

			Rs.
1.	P. W. Department	... ..	85,646
2.	Survey of India	... ..	72,679
3.	Defence Department (excluding Ordnance)...		49,984
4.	Railways	... ..	42,721
5.	Forest Departments	... ..	14,952
6.	Education Departments	... ..	7,517
7.	Medical Departments	... ..	6,485
8.	Other Civil Departments, which include Excise, Jails, Meteorological, Judicial, R. I. Marine. Posts & Telegraphs, Geological, Botanical and Archæological Survey Depts. etc. ... ..	... ..	68,829
9.	Government Officers, Municipalities, District Boards, Indian States, etc. on cash payment.		57,549
TOTAL			4,06,362

The above were spread over Central and Provincial Government departments of various provinces and countries outside India as shown below:—

	Rs.
Punjab	87,759
Bengal	79,418
Orissa	18,614
Bombay	16,591
Central Provinces & Berār	14,206
United Provinces	14,193
Bihār	12,049
Assam	8,662
Madras	7,980
North West Frontier Province	6,532
Sind	3,831
Andamans	532
Survey of India	72,679
Defence Dept. (excluding Ordnance)	49,984
Burma	7,520
Irān	4,607
Irāq	1,205
TOTAL ...	4,06,362

Issues by the Serviceable Store amounted to 42,590 instruments. The Stores Section dealt with 15,917 requisitions from workshops. The Clerical Section received and disposed of 22,022 letters. The Accounts Section dealt with 5,347 invoices, 1,647 bills and vouchers for the local purchase of instruments and materials etc.

During the year 2,902 instruments have been deposited by various Government departments as no longer required. Credit afforded by this office for the above instruments returned on deposit amounted to Rs. 7,295. These instruments will be reconditioned for reissue at reduced prices.

A sum of Rs. 2,392 was realised by the disposal of surplus and obsolescent stores and scrap materials.

149. Special Instruments.—The manufacture of the following special instruments was undertaken during the year for various indentors who were unable to have the work done elsewhere in India:—

- (i) Five Test Type apparatus for the Eye Infirmary, Medical College Hospitals, Calcutta.

- (ii) One Steel Straight Edge, 10 ft. long, 4" wide, 1" thick for the new Howrah Bridge Commission. This was checked by the Auto Collimation method and the greatest error over the whole length was found to be less than half of one thousandth of an inch *i.e.* .0005".
- (iii) Four large steel Set Squares with edges trued by optical methods for the new Howrah Bridge Commission. These were 4½ ft., 3 ft. 2½ in., 2 ft. 6 in., 1 ft. 9½ in. The three smaller ones had bubbles and foot-screws on the shortest side for adjustment purposes.

Items (ii) and (iii) were employed in checking the perpendicular structures of the bridge from the foundations.

- (iv) One Fibre Rigidity Tester and one Ballistic Fibre Strand Tester, for the Director, Technological Research Laboratories, Indian Jute Research Committee, Calcutta.
- (v) One Offset Scale in plate glass of new type with separate vernier and pricker and ten Offsetting Sight apparatus for the O.C., Lahore Survey Detachment.
- (vi) 227 Sets of Hydrometers, pocket, brass, for excise purposes, in box complete with 10 weights, magnifying glass, thermometer and test jar and 227 sets of grain weights with tweezers, in teak wood boxes for the Commissioner of Excise and Salt, Bengal.
- (vii) One Research Calliper 48" to be used in measuring diameter of trees for the Provincial Silviculturist, Ootacamund.
One each of Callipers for measuring dia. 30" and 10" for the Director General of Archaeology in India, New Delhi.
- (viii) Five parallel plate glasses of an accuracy within ten seconds of angle for the Allahābād University, Physics Department.
- (ix) One Teak wood Sounding rod 10 ft. long, 1 in. dia. graduated in feet, and quarters with pointed shoe for the Executive Engineer, Cossye Division, Midnapore.
- (x) One Slider for the Hardy Boundary Friction Testing Machine for the Chief Controller of Standardization, Railway Board, New Delhi.
- (xi) Two new Flexible Shafts for the Director, Geodetic Branch, Dehra Dūn.

150. Miscellaneous. At the request of the Secretary, Institution of Engineers (India) Ltd., Calcutta, a selection of apparatus was loaned to him on 25th March 1939 as an exhibit of Survey instruments manufactured in India.

The old wooden racks in the stores were dismantled and replaced by steel racks and almirahs. Old records were weeded out and arrangements made for a new record room.

The Stores Office was amalgamated with the main office and the stores verandah converted to a show room to display samples of instruments carried in stock and instruments and apparatus manufactured in the office.

151. Summary. The following table shows the value of work done during the last three years. It will be observed that there is again a large increase in the value of new instruments handled and in the output of the workshops.

Sale.	1936-37.	1937-38.	1938-39.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
1. Total value of stores issued ...	2,46,192	2,85,149	3,29,428
<i>Out-turn in Works:—</i>			
2. Total value, manufacture of new instruments and components—	1,81,765	1,69,952	1,86,684
3. „ value of repairs to orders— ...	81,585	84,080	76,934
4. „ value of instruments reconditioned for issue— ...	57,762	48,856	54,440
5. „ value of adjustment and cleaning charges ...	3,839	5,582	4,366
6. „ value of work done in the workshop as per items 2 to 5 above— ...	2,74,951	3,07,970	3,22,424
7. <i>Book value of stock in—</i>			
(a) Serviceable store ...	3,15,206	2,79,009	3,06,493
(b) Repairable „ ...	1,50,148	1,41,808	1,32,754
(c) Material „ ...	1,43,937	1,07,089	1,13,315
8. <i>Value of new instruments—</i>			
(a) Purchased locally ...	59,668	69,913	78,857
(b) Imported through the Stores Department, London— ...	12,396	25,722	49,058
9. Value obtained by sale of obsolescent and condemned stores— ...	3,773	2,433	2,392
10. <i>Employees—</i>			
(a) Total number of employees on register on 31st March ...	344	376	365
(b) Cost of employees in workshop including pension contribution	1,42,551	1,42,061	1,41,858

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A.	Modern Topo. surveys and compilation	<i>At End.</i>
B.	Seasons of survey and revision	" "
C.	Maps published on 1 inch and $\frac{1}{2}$ inch scales	" "
D.	" " " $\frac{1}{4}$ inch scale	" "
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F.	Carte Internationale du Monde, 1/M scale	" "
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